AFIT/GMO/LAL/99E-11

THE APPLICATION OF AUTOMATIC IDENTIFICATION TECHNOLOGY FOR INTRANSIT VISIBILITY AT REMOTE LOCATIONS

GRADUATE RESEARCH PAPER

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GRADUATE RESEARCH PAPER

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Abstract

Air Mobility Command (AMC) is responsible for collecting intransit visibility (ITV) data at remote and austere airfields. Automatic identification technology (AIT) is emerging as a system for quick and accurate data capture. This paper examines the application of AIT at remote locations to obtain ITV. Four areas are addressed: processes, training, manning, and equipment.

Obtaining ITV at remote locations is currently a complicated combination of manpower and time intensive processes. AIT is capable of streamlining these processes by reducing cargo and passenger processing times. Additionally, it provides highly accurate data. Although AIT offers several significant benefits, the technical nature of AIT equipment requires skilled personnel for setup, operation, and troubleshooting. Recent AIT exercise scenarios highlighted the need for training programs at all levels from aerial port personnel to commanders. Furthermore, it does not appear that the application of AIT will reduce manning requirements. Despite these disadvantages, AIT could improve ITV at remote locations. Given that past attempts to collect ITV data at remote or austere locations have been manpower and time intensive, AIT could eliminate these problems in the future. Consequently, AMC should plan to use AIT to improve ITV at remote locations.

THE APPLICATION OF AUTOMATIC IDENTIFICATION TECHNOLOGY FOR INTRANSIT VISIBILITY AT REMOTE LOCATIONS

I. Overview

Background

"In every major deployment during the 20th century, the Department of Defense has been plagued by a lack of visibility over shipments and units entering a theater of operations" (USTRANSCOM, 1997:iii). For example, during DESERT STORM, the lack of inventory information necessitated the opening and resealing of approximately half of the 40,000 containers shipped to Southwest Asia. In response to this problem, General Rutherford, Commander in Chief, United States Transportation Command, declared 1994 as the "Year of Intransit Visibility." In February 1995, the Department of Defense (DoD) published the Defense Intransit Visibility Integration Plan outlining intransit visibility (ITV) requirements and key processes. The plan was revised and republished in 1997. Both versions outline the importance of automatic identification technology (AIT) for accurate and timely data collection.

The United States Transportation Command (USTRANSCOM) continues to place high priority on intransit visibility of cargo and personnel. Over the last several years USTRANSCOM has exercised its ability to capture cargo and personnel visibility in the Defense Transportation System (DTS). Several recent exercises illustrate shortcomings with the current ITV procedures. During BRIGHT STAR 98, much of the data was

available in the Global Transportation Network (GTN) but most of it had to be entered by hand, a time-intensive process. To ease this workload on the deployed aerial ports for DESERT SCORPION, additional manifesting teams were sent to more than 25 locations to capture the data, a manpower-intensive process (Young, 1998). However, in today's military, time and manpower resources are at a premium and should be used efficiently. One cutting-edge information technology that could eliminate these time- and labor-intensive data gathering processes is automatic identification technology.

In November of 1997, DoD released the Logistics Automatic Identification Technology Concept of Operations. This document acts as a roadmap for AIT infrastructure development and implementation over the next three years. This will include equipment for reading and creating 2D bar codes, optical memory cards, and radio frequency tags at fixed aerial ports. Locations without permanent capabilities such as remote or austere deployed locations will be serviced by a "fly-away kit" that can provide a temporary capability (DoD, 1997b:3-5).

Research Question

Although the importance of obtaining intransit visibility at remote or austere locations has been identified, Air Mobility Command's (AMC) actual procedures are poorly defined. Given that past attempts to collect intransit visibility at these locations have been manpower and time intensive, could AIT eliminate these problems in the future? The purpose of this paper is to address this question by analyzing the application of AIT for obtaining intransit visibility at remote locations. The paper is organized around three questions germane to AIT and intransit visibility. The first asks the

deceptively simple question, How does AMC currently capture ITV data at remote locations? The second question is, What automatic identification technologies and products are currently available? The final question is, What lessons have been learned by other military commands and civilian organizations employing AIT? Answers to these questions will determine AMC's ability to effectively apply AIT fly-away kits for remote location ITV.

Scope and Assumptions

The field of automatic identification technology is growing rapidly. New technologies and methods of application are constantly being developed. Consequently, this paper will examine readily available AIT technologies. No attempt will be made to incorporate technologies that are under development.

AMC considers a remote location to be any operating location that does not have a permanent AMC presence. For example, Ramstein AB in Germany is not an AMC base but it is the home for the 621st Air Mobility Support Group (621 AMSG) from AMC. Application of this definition shows that Ramstein should not be considered a remote location. Furthermore, the temporary presence of a Theater Airlift Control Element (TALCE) does not change a location's remote status. When referencing fly-away kits, the DoD considers a field to be remote or austere when there is no permanent AIT infrastructure (DoD, 1997a).

The capability required at remote locations also shapes the scope of this paper. The AIT Concept of Operations states that "each node in the logistics chain needs to be able to create and read AIT devices and to provide the information on those devices to

logistics AISs [automated information systems]" (DoD, 1997b:3-5). This paper focuses on the equipment required for AMC to gather information for cargo onloads and offloads.

The final decision on which automatic identification technologies are used rests with the DoD. Since that information has not been finalized, information needs to be gathered on which technologies the DoD is considering for implementation. Based on discussions with personnel in USTRANSCOM J4 Logistics Integration Division, it appears that three different types of technology are being considered. First, smart cards will be used for manifesting passengers. Second, individual items will be tracked through the use of 2D bar codes. Third, radio frequency (RF) tags will be used to identify pallets and containers of cargo (each containing multiple individual items) (Kelly, 1998).

Preview of Remaining Chapters

The paper structure follows the investigative questions with one chapter devoted to answering each of the three questions. Chapter II explains how AMC currently collects intransit visibility information. It gathers information from many sources to describe the procedures for remote location ITV. The capabilities of smart cards, 2D bar codes, and RF tags are covered in Chapter III. This chapter also examines how DoD intends to use each of the technologies. Pictures and descriptions of the systems and components that are available commercial-off-the-shelf (COTS) are included. Chapter IV addresses current AIT practices within the military. It describes and analyzes AIT scenarios in United States European Command (USEUCOM) and United States Pacific Command (USPACOM). Further, this chapter summarizes lessons learned from both

military and civilian AIT programs. The last chapter integrates information from the previous three chapters to answer the research question and make recommendations. The main emphasis of this chapter is to determine how applying AIT impacts AMC's intransit visibility processes, training requirements, manning requirements, and required equipment.

II. ITV at Remote Locations

Introduction

A comprehensive understanding of the current procedures for obtaining intransit visibility at remote locations is required before attempting to integrate automatic identification technology. While most anyone in AMC can discuss why ITV exists, the who, what, when, where, and how are mostly not understood. As shown in Figure 1, the ITV process is complex with numerous combinations of CONUS, intertheater, and intratheater cargo and passenger movement.

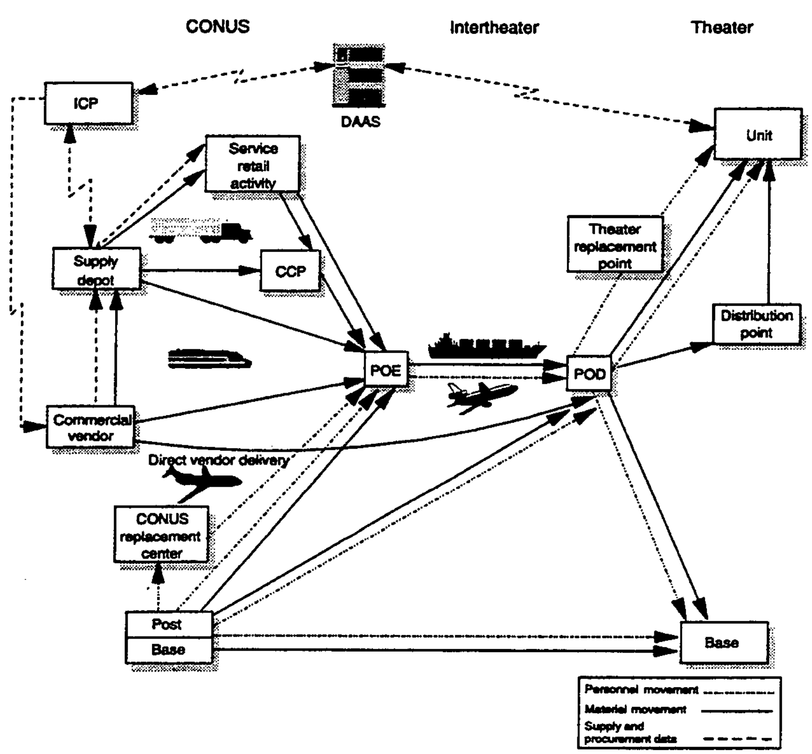

Figure 1. **Current Operating Environment** (USTRANSCOM, 1997:1-2)

The process appears even more complex when one examines the web of relationships between information systems that ultimately provide ITV (Figure 2). The details of this process (i.e., meaning of acronyms and nodes) are not important. The purpose of the figure is to illustrate the complexity of the ITV process.

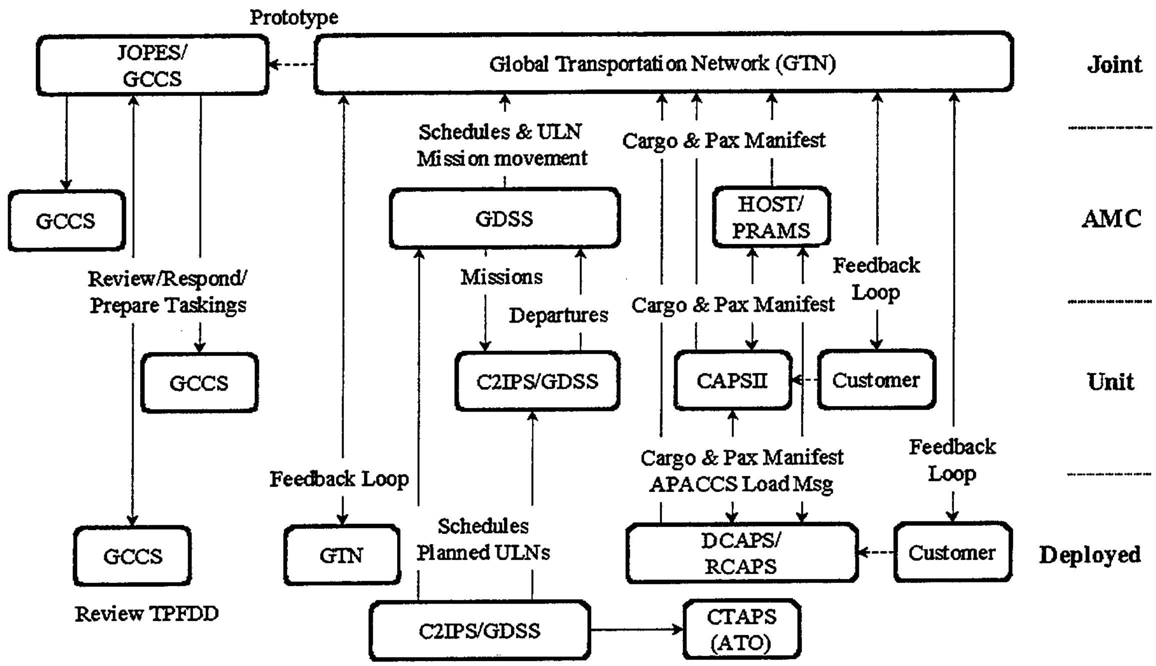

Figure 2. **ITV Information Systems** (Monday, 1999)

Even the Air Mobility Command recognizes the complexity of this process in its Air Mobility Master Plan (AMMP) 1998: "The current processes for mobility information gathering and management involve a complicated combination of organizational, operational, and procedural process" (AMC, 1997:4-48). The remainder of this chapter will focus on this ITV process at remote locations.

Establishing the Need

The easiest answer to why ITV is required at remote locations comes from USTRANSCOM's definition of ITV. "Intransit Visibility is defined as the ability to track the identity, status, and location of DoD unit and non-unit cargo and passengers, patients, and personal property from origin to consignee or destination during peace, contingencies, and war" (USTRANSCOM, 1997:1-1). Certainly many of the origins and destinations for AMC missions are remote locations. Figure 3 shows that in FY98 AMC traveled to most of the countries in the world. The majority of these destinations have no permanent AMC presence or AIT capability.

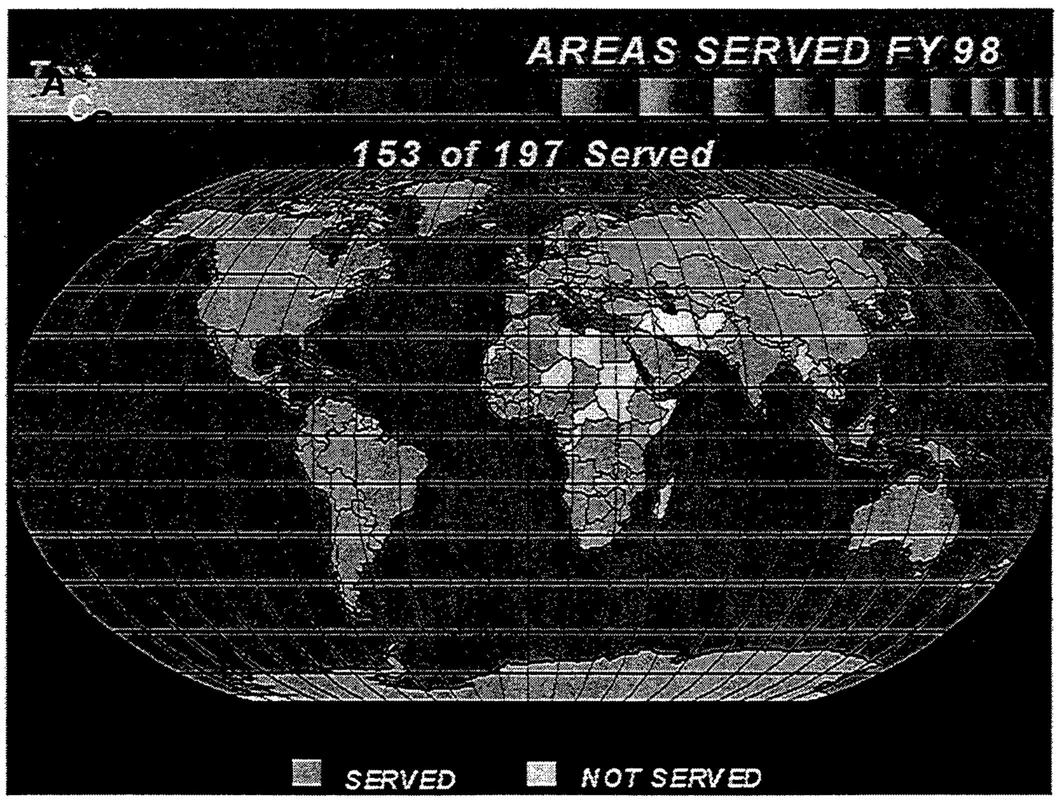

Figure 3. **Areas Transited by AMC** (HQ AMC/XO, 1999)

Commanders at levels both above and below USTRANSCOM stress the importance of intransit visibility. While Joint Vision 2010 does not mention intransit visibility directly, it does discuss focused logistics. Successful military operations in the future will require "the fusion of information, logistics, and transportation technologies to provide rapid crisis response, to track and shift assets even while en route" (CJCS, 1997:24). This is exactly the type of capability that ITV provides. At a lower level, the AMMP 1998 says that "all aspects of Global Air Mobility must replumb themselves culturally so that the passing of timely accurate information becomes the fundamental prerequisite to successful operations" (AMC, 1997:v). During his keynote address at the Airlift/Tanker Association Conference, General Robertson said, "one of the biggest 'to dos' on our plate is intransit visibility" (Robertson, 1998). In fact, the update to the 1998 AMMP shows ITV systems in the top five modernization priorities for the command (AMC, 1999).

Just because a few "higher ups" created some definitions and requirements mandating ITV does not make it important. Understanding ITV's inherent benefits shows its importance.

> The primary benefits of ITV are enhanced warfighting capability and reduced operating costs. The enhanced warfighting capability would stem from DOD's increased ability to divert and reconstitute shipments, plan transportation movements, exercise sound traffic management, and ensure personnel and material reach their destination in a timely and complete manner. The lower operating costs would result from greater efficiency in both transportation and supply operations. (USTRANSCOM, 1997:4-1)

Much has been written about the misdirecting and mislabeling of containers during Desert Storm. The monetary costs and implications to the warfighter have not received as much coverage. The Defense Advanced Research Projects Agency (DARPA)

conducted a detailed analysis of the Desert Storm scenario that highlights ITV's two main benefits.

> [They] found that the operation could have been shortened by 100 days and the amount of material shipped could have been reduced by 1 million tons. By so doing we also could have avoided spending over $650 million dollars in transportation costs alone, let alone the cost of material. The lack of quality and timely information led to just about every logistics problem encountered. (Lynn, 1997:15)

Why ensure ITV at remote locations? The reasons go beyond just being told to do it. AMC, as a component of USTRANSCOM, is responsible to support the warfighting CINCs. Table 1 shows that logistics and distribution were problems even before Desert Storm. All these problems could have been lessened or eliminated with good intransit visibility. Remote ITV is what is right and what is best for the warfighter. In the words of General Kross, "intransit visibility of personnel, patients, and cargo is essential for the warfighter—forces and equipment in the mobility system do the warfighters no good if they don't know where it is or when it's coming" (AMC, 1997:v).

Table 1. **Distribution Problems in Previous Conflicts** (Gross, 1995:2-3)

Problem	Conflict			
	Korea	Vietnam	Persian Gulf	Somalia
Supplies lost	Yes	Yes	Yes	Yes
Long requisition-to-receipt times	Yes	Yes	Yes	Yes
Multiple requests for same part	Unknown	Yes	Yes	Yes
Backlogs at CONUS and theater distribution nodes	Yes	Yes	Yes	No
Poor documentation of inventory and receipt	Yes	Yes	Yes	Yes

Defining the Requirements

The Defense Intransit Visibility Integration Plan provides detailed information on the requirements of the ITV system.

> It must track personnel [and cargo] movements from origin to destination. It must identify the contents of a shipment and monitor the shipment's location as the shipment moves from origin to destination. It must be linked to the Global Command and Control System (GCCS) which is replacing the Worldwide Military Command and Control System (WWMCCS) and Joint Operations Planning and Execution System (JOPES) as DOD's central command and control system. It must enhance DoD's ability to track individual requisitions, items, personnel, and unit movements; and identify, reconstitute, and divert shipments to new destinations. It must have the capability to operate from origin to destination (including redeployments and retrograde shipments); be available during peace, contingencies, and war; and support both the operations and logistics communities. (USTRANSCOM, 1997:2-1)

This guidance requires that personnel and cargo are tracked from all origin to destination locations, regardless of whether a location is remote. Although, AMC can limit its concern to the geographic locations from the port of embarkation (POE) through the port of debarkation (POD), a theater commander is responsible for all intratheater intransit visibility.

Ideally, data would be captured at every POE and POD location. Unfortunately, current manpower availability does not allow for this goal. Current guidance to the Tanker Airlift Control Center (TACC) Contingency Operations Section is to capture 100% ITV information at all onload locations. It is assumed that if a plane departed with the cargo onboard, the cargo also arrives once the plane arrives at its destination (Trotter, 1999). Additionally, AMC's guidance for redeployments states that manifest teams will not be sent to locations for the sole purpose of receipting cargo (HQ AMC/DONI, 1998:2).

The DoD ITV requirements statement also indicates that data should be collected during both peace and war. Stated otherwise, data must be collected all the time. This is not surprising considering the importance of intransit visibility to the warfighter and ITV's ability to reduce operating costs during normal day-to-day operations. Another aspect that must be considered is timeliness. AMC provides guidance on the timeframe within which ITV information must be made available. A message released by the Aerial Port Operations Division (HQ AMC/DON) states that within 30 minutes of aircraft departure, the mission must be "lifted." This causes the Consolidated Aerial Port System II (CAPSII) to transfer the ITV data to Global Transportation Network (GTN). The message also requires confirmation of data transfer to GTN no later than 90 minutes after aircraft departure (HQ AMC/DON, 1998).

As indicated by the DoD ITV guidance statement, information needs to be captured during the full spectrum of operations from peace to contingency to war. Additionally, the data must be sent within 30 minutes and verified available within 90 minutes. This is no easy task considering that much of the data is entered by hand.

The DoD ITV requirements statement provides a starting point for discussing what data must be captured. "It must enhance DoD's ability to track individual requisitions, items, personnel, and unit movements" (USTRANSCOM, 1997:2-1). AMC's AMMP 1998 guidance is more precise. It requires every passenger, patient and piece of cargo within the Defense Transportation System to be tracked (AMC, 1997:v). If Air Mobility Command is moving the cargo or passenger, it needs to have intransit visibility; however, what specific passengers and cargo information is required to be collected?

The Defense Intransit Visibility Integration Plan describes the different data required for passenger and cargo movement. Passenger movements require the following data: passenger's name, Social Security Number, service specialty code, and unit line number (ULN). Cargo requires even more information: shipment identification number, transportation control number (TCN), ULN, unit identification code (UIC), national stock number (NSN), and requisition number. Not all of this data is required for every passenger or piece of cargo; some of the data is only required for unit moves (USTRANSCOM, 1997:vi-xi). To accumulate all this data, AMC requires cargo and passengers to be manifested with Military Standard Transportation and Movement Procedures (MILSTAMP) level detail (HQ AMC/DON, 1998). Besides the cargo and passenger data, mission information must also be entered. The manifest data is useless if GTN data does not record where the cargo currently is and what mission it is on. In fact, HQ AMC/DON has directed that the mission number, POE, and POD in CAPSII be compared with the data in the Command and Control Information Processing System (C2IPS) or the Global Decision Support System (GDSS) (HQ AMC/DON, 1998).

What data must be collected to ensure ITV at remote locations? Both descriptive data for the cargo or passengers and mission data for the aircraft must be available in GTN. AMC notes that "our definition of successful ITV is 'drillable' cargo and/or pax data, where GTN links the manifest data directly to the mission number" (HQ AMC/DON, 1998).

Analyzing the Process

Unfortunately, the ITV requirements statement does not provide guidance on who is to collect ITV or how it is to be collected. "It is not intended to provide either technical architecture, user interface requirements, or the detailed requirements for the completed system" (USTRANSCOM, 1997:1-2). This lack of guidance forces a look elsewhere. Due to staff undermanning, the current AMC supporting document is in draft and unavailable. It should provide detailed guidance for the deployable ITV teams. Tentative release date is June 1999 (Diliberto, 1999).

Air Mobility Command is in the process of updating the ITV unit type codes (UTC). Once approved, it will help answer who captures ITV information. Table 2 shows an extracted entry from the "old" AMC Air Transportation Unit Type Code (UTC). This is currently the only official UTC that deals with deployable ITV collection teams (Trotter, 1999).

Table 2. **AMC Air Transportation Unit Type Code** (HQ AMC/XOGM, 1996)

ITV	2T251	Remarks
UFBV1-5	5	Intransit Visibility Team (MOG-4/24 Hr Ops)

The second piece of "old" documentation is the Mission Capabilities Statement (MISCAP) for the UTC.

> Provides support personnel to set-up and operate RCAPS [Remote Consolidated Aerial Port System]/DCAPS [Deployed Consolidated Aerial Port System] equipment at passenger and cargo on/offload locations. Includes system administrator. Capable of supporting a 24-hour operation. This UTC can support unit move operations up to a MOG [Maximum on Ground] of 4. ARC [Air Reserve Component] personnel are only trained in the operation of the equipment. (HQ AMC/XPMSX, 1999)

These two pieces of "old" information do not provide specific guidance as to who should deploy to capture ITV data at remote locations.

Fortunately, over the last year, AMC has provided "new" guidance in the form of message traffic. Three messages transmitted in June and July of 1998 signified the start of the changes. One started with the sentence, "We are no longer using the current ITV UTC, UFBV1, for deliberate planning" (HQ AMC/DOZ, 1998a). Another mentioned that AMC had submitted a new UTC, UFBVP, for approval. "UFBVP is a totally new UTC that calls for a 3 person super RCAPS team to support a MOG of two for 12 hours. There will be an accompanying equip[ment] UTC." It apportioned 39 teams to 21st Air Force, 31 teams to 15th Air Force, and 30 teams to the Air Force Reserves and Air National Guard (HQ AMC/DOZ, 1998c). The third message reaffirmed the new UTC and provided two additional UTCs. The UFBVE is the equipment UTC mentioned in an earlier message. The UFBVA is an additional equipment and manpower UTC for working in austere locations or when 24-hour operations are dictated (HQ AMC/DOZ, 1998b). Appendix A contains a copy of this message.

The aerial port personnel in the 621st Air Mobility Operations Group (AMOG) at McGuire AFB provide practical guidance gained through real-world application of these messages. The normal deployable ITV team consists of three enlisted transporters (2T2XX). One individual, normally the team leader, will be a system administrator. The system administrator is responsible for setting up, networking the computer equipment, and establishing communications with GTN. The other two team members actually use the computers to enter the data into RCAPS as the aircraft arrive and depart. One of the individuals should be a passenger specialist and the other should be a cargo specialist.

This three-member team has the capability to handle a continuous MOG of two aircraft during twelve-hour operations (Norwood, 1999).

The answer to who should deploy to collect remote location ITV data reveals developing official guidance from AMC. The three UTCs awaiting approval may take two years to be approved (Trotter, 1999). Because the UTCs have not been approved, no designed operational capabilities (DOC) statement shows a requirement for these deployable ITV teams. Consequently, the squadrons have received no additional manning to cover the three-member deployable teams or money to buy equipment.

Determining how to collect ITV information is also difficult to answer. The current procedures for capturing ITV at remote locations seem to be spread among several different policy letters and concepts of operations. Most of this guidance lacks detail. The specific guidance comes from real-world experiences.

There are three distinct phases to remote location ITV: aircraft command and control, cargo and passenger data capture, data transmission to GTN. Figure 4 shows each phase and their relationship. The AMC Exercise Intransit Visibility Concept Operations places the responsibility for the last two tasks on the ITV team. "Units will manifest cargo and passengers using CAPSII or S-RCAPS at deployment on-load locations, through-load locations (as necessary), and at theater locations. Manifest personnel will ensure timely transmission of airlift cargo and passenger data to GTN for ITV" (HQ AMC/DONI, 1998:2). The first task, aircraft command and control, is not the responsibility of the ITV team. Arrival and departure information is entered into C2IPS by the TALCE and gets passed to GDSS which updates GTN. In the absence of a

TALCE, the aircrew passes this information to TACC who enters the information directly into GDSS.

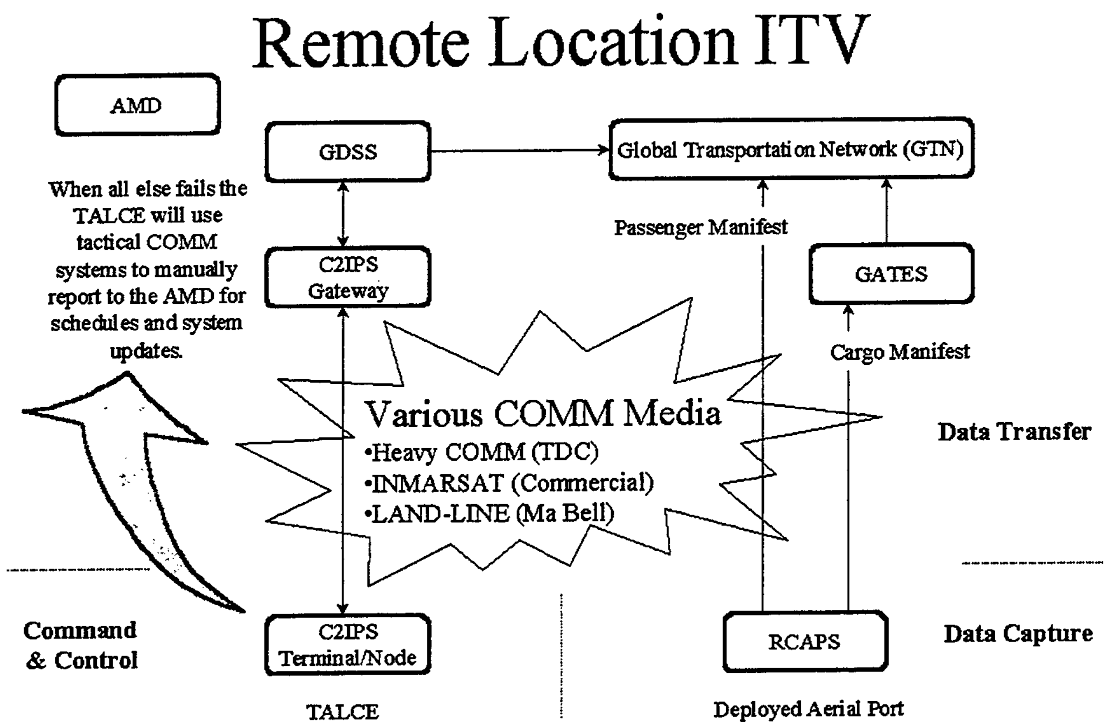

Figure 4. **Three Phases of Remote ITV** (Monday, 1996b)

Capturing cargo and passenger data can be time intensive for the deployed team. If the user shows up with a complete electronic manifest, the process goes quickly. All the ITV team has to do is run some conversion programs to reformat the data for RCAPS. AMC does provide guidance on what to do if no electronic data is available. "Data not provided in electronic form will be 'hand-jammed' by AMC port personnel" (HQ AMC/DONI, 1998:4). While hand jamming is more time intensive than the conversion programs, an even bigger problem is incomplete data (data does not meet MILSTAMP). The deployed team must track down the necessary data for entry before RCAPS will

accept the information (Norwood, 1999). In the end, the ITV team must ensure all the required data is in RCAPS or else the data cannot be transmitted to GTN.

Transmission of cargo data to GTN is by any means possible. These include, but are not necessarily limited to, landlines, satellites, and networks. In fact the Deployed ITV System Guide lists ten different telephone numbers for establishing a data link. There are commercial, Defense Switching Network (DSN), and International Maritime Satellite (INMARSAT) telephone numbers for both the GTN and RCAPS servers at Scott AFB. If the remote location has computer network capability, it may be possible to pass the data that way. Each location has unique communications available, the ITV team must determine the best and most reliable means to use.

That is the macro level overview of how the data is captured and transmitted to GTN. A more in-depth look at the equipment and training required to accomplish the mission provides a greater appreciation for the complexity of the process. The UFBVE UTC provides general guidance on what equipment the deployable ITV team takes. Since, every remote location has different existing capabilities, there is flexibility for each unit/team to determine what they want to take. Generally, teams deploy with three laptops, (one to capture passenger data, one to capture cargo data, and one to act as a server and transmit the data to GTN) a printer, all the necessary cables for networking the laptops, and various extension cords, surge protectors, phone cable, etc. Appendix B contains the equipment list used by the ITV teams in the 621 AMOG to fulfill the UFBVE requirement. Noticeably absent is any INMARSAT equipment. HQ AMC does not fund the equipment for remote ITV teams, since they are not an official UTC, and the

AMOG has not found the money (Norwood, 1999). Appendix C contains their UFBVA equipment list.

The equipment setup is complicated enough that the Air Mobility Warfare Center (AMWC) created a five-day course for system administrators. The course deals entirely with setting up and networking the computer equipment at the remote locations. The course description details the objectives.

> Provides supplemental training in the knowledge and skills necessary to perform intransit visibility capabilities in a deployed operation. Prepares students to deploy to a bare-base location and configure a computer system to provide continuous intransit visibility (ITV). Subjects include basic ITV background information, equipment setup and configuration, hub connections and dialing into a server, ITV application through RCAPS, and some database management. Training is student-centered with hands-on exercise scenarios. (AMWC/WCOT, 1999:iii)

Appendix D contains a copy of the course syllabus. It does not cover data collection and entry or data transmission and tracing (Norwood, 1999). The AMWC course also produces a 175-page guide. It provides system administrator's with detailed systematic instructions for setting up the computer equipment. It also contains several articles about ITV evolution, copies of three HQ AMC/DOZ messages, and a more detailed equipment list. The table of contents from the AMC Deployed ITV System Guide is shown in Figure 5.

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Figure 5. **AMC Deployed ITV System Guide** (AMWC/WCOT, 1999:i-ii)

Teams "deploying with RCAPS will ensure personnel responsible for manifesting are familiar with data requirements to ensure successful ITV data capture." Additionally, they need to be familiar with the Transportation Coordinator's Automated Command and Control Information System (TC-ACCIS), PAS2 (a conversion program for tab or comma delimited data), and the Quick Manifest Program (QMAN) for converting electronic data provided by the Army and Marines (HQ AMC/DONI, 1998:2). To meet these requirements, units have developed in-house training programs. The 721st Air Mobility Squadron (721 AMS) developed a five-day training program for the cargo specialist and a four-day course for the passenger specialist. These courses explain how

to enter data into the RCAPS computers. Most newcomers to the 721 AMS also spend some time at Dover AFB's aerial port getting hands-on experience (Norwood, 1999).

How does ITV data get collected at remote locations? The most straightforward answer is by making it the responsibility of dedicated, hardworking, motivated Air Force personnel who will do whatever it takes to get the job done. Remote location ITV is a complicated process that requires a great deal of equipment and as much training. ITV teams need to be flexible, adaptive, and resourceful. More importantly, they need to be adequately manned and funded.

Conclusion

Ensuring intransit visibility at remote locations is obviously a high priority with DoD, USTRANSCOM, and AMC. ITV of personnel and cargo at remote locations enables AMC, as a component of USTRANSCOM, to fully support warfighting CINCs. Despite the importance of capturing ITV at remote locations, accomplishing this task is difficult for several reasons. First, ITV needs to occur across the full spectrum of engagement (i.e., both peacetime and wartime) and it must be near real-time. The value of ITV is degraded when it is incomplete or late. Second, the amount of cargo and passenger data that must be collected is extensive. When users show up with their data in non-standard formats, it results in excessive manual data entry. With all this data being entered, frequently by hand, inconsistent data quality can be expected. Third, the question of who will collect ITV at remote locations is still an unresolved issue. Unapproved UTCs for collecting ITV information could lead to manning shortages and lack of training. Finally, lack of funding for equipment is a serious problem (e.g., no

INMARSAT equipment). The Defense Intransit Visibility Integration Plan identifies this problem as well by indicating that the "lack of assured communications in remote theaters could restrict ITV of cargo and personnel within theaters" (USTRANSCOM, 1997:4-2).

III. Selected AIT Technologies

Introduction

Automatic identification technology is a growing industry. Due to its rapidly changing nature, the World Wide Web is ideally suited for making AIT information available. Most organizations have not missed the opportunity. Typing "AIT" into an Internet search engine results in well over 10,000 websites. These sites generally fall into one of two categories. Educational sites are produced by trade organizations, educators, consultants, and manufacturers. The military also has several informational sites. These sites provide background on all different types of AIT technologies. Most sites include a brief historical development of the different technologies. They also include a discussion of each technology's unique characteristics, analyzing their strengths and weaknesses. Most include several real world applications or case studies. The second category is advertising websites. These sites are developed by corporations. Some contain educational material but most just promote their products. Colorful pictures and detailed specifications provide plenty of information. Scenarios describe how these products can help companies improve their processes.

The plethora of information makes it difficult to know where to begin. A definition is always a good pace to start. The Air Force AIT Program Management Office home page provides the following definition of AIT. "Automatic Identification Technology is a generic name given to devices used to automate data collection in a variety of applications. The goal of AIT is to provide cost savings by expediting the collection of accurate data" (AF AIT PMO, 1999). The Automatic Identification

Manufacturers (AIM) is a global AIT trade organization. They identify six broad categories for AIT: optical (bar codes), magnetic, electromagnetic (RFID), biometric, touch, and smart cards (AIM, 1999b). Table 3 shows specific technologies within each category.

Table 3. **Categorized AIT Technologies** (AIM, 1999b)

Optical	Bar Code, Optical Character Recognition, Vision Systems
Magnetic	Magnetic Stripe, Magnetic Ink Character Recognition
Electromagnetic	Radio Frequency Identification, RF Data Communications
Biometric	Voice Recognition Systems, Fingerprints, Retinal Eye Scan
Touch	Touch Screens, Button Memory
Smart Card	Card-based Storage/Retrieval Devices

Each technology has different characteristics. Figure 6 shows how five different common technologies fit on relative scales of four different characteristics.

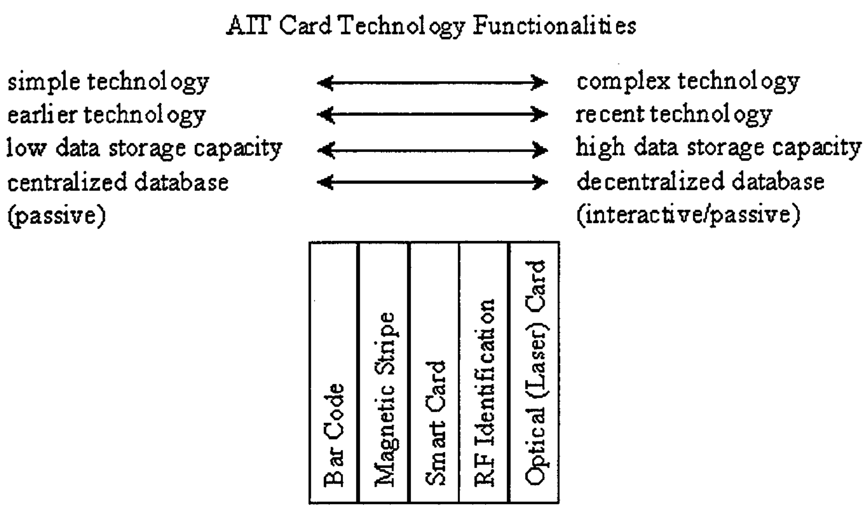


Figure 6. **General AIT Characteristics** (Bower, 1994:93)

There is a wealth of available online and printed AIT information. Table 3 and Figure 6 are cursory summaries of this information. This chapter condenses this

information and provides an examination of the characteristics and capabilities, DoD intended use, and available COTS equipment for each of the three supported DoD technologies: 2D bar codes, smart cards, and radio frequency identification.

Characteristics and Capabilities

There is no intent, nor enough space, in this section to describe the history and development of these technologies or to detail how they work. These topics will be covered to the extent that they are required to understand the technological strengths and weaknesses. The Air Force Materiel Command and Automatic I.D. News have both developed outstanding websites. The sites are excellent sources for background information on AIT. Each contains over 75 links to articles and other applicable websites. They can be accessed through the Internet at http://www.afmc.wpafb.af.mil/HQ-AFMC/LG/LSO/LOA/other.htm and http://www.autoidnews.com/technologies/concepts.htm. This section provides a description and picture for each of the technologies. There is also a description of how the device operates encompassing its strengths and weaknesses.

Linear Bar Codes. While the linear bar code is not one of the three previously mentioned technologies, DoD is not going to abandon linear bar codes any time soon. Bar coding technology first came about in the early 1950s. They are an excellent and inexpensive tool for AIT. Figure 7 shows an example of one type of linear bar code. The Air Force Materiel Command's description of the bar code encompasses all aspects of the AIT definition.

> A bar code is an array of parallel narrow rectangular bars and spaces that represent a single character in a particular symbology. These bars and spaces are arranged in a particular order defined in the symbology. Bar codes are printed, scanned, decoded and then transferred to a host computer. This technology relieves the user of the tedious and error prone task of having to read an alphanumeric label on an object and then transcribing the label contents on a paper form or key-entering database. With bar code technology, the time required to identify objects and enter the identity code into a database has been significantly reduced for many logistics-related operations at warehouses, retail stores, battlefields, hospitals, etc. (Young, 1996:48)

4 1 2 9 6 3 8 0 0 9

Figure 7. **Linear Bar Code** (AIM, 1999a)

Bar codes can be read with hand held scanners or fixed scanners. This necessitates physically being able to see the tag which may not always be easy. On average, one tag contains 8 to 30 characters (AIM, 1999a). This is not necessarily a weakness but is certainly a limitation. Durability is one of the linear bar code's biggest draw backs. The tag does not read well if it gets wet, dirty or torn. The readers are also susceptible to low and high levels of light. Unfortunately these are common characteristics of the environmental conditions that occur day to day. Linear bar codes do have several strengths. It is a simple and proven technology that is inexpensive to produce. The equipment required to scan a bar code is easy to use and very portable. (Watt and Smith, 1997:10-11). For the controlled operating environments of most commercial industries, the advantages of low cost and ease of use easily outweigh the

disadvantage of poor performance in extreme environments. The military's wide variety of operating environments make the linear bar code less appealing.

2D Bar Codes. The introduction of 2D bar codes alleviates many of the environmental concerns of linear bar codes. The 2D codes are readable in a variety of light levels. Dirt and grime seldom pose a problem and many tags can be read if ripped or partially destroyed (Watt and Smith, 1997:13).

Figure 8. **2D Bar Code** (AIM, 1999a)

The process for reading the 2D tags is the same as the linear tags. Unfortunately, the same scanner cannot read both types of tags. The 2D scanners require more complicated circuitry to interpret the tags and are therefore more costly. The tag does have a much increased data capacity. Each 2D tag can contain 7000 numeric or 4200 alphanumeric characters depending on the tags size (AIM, 1999a). Robert LaMoreaux, in his book on bar codes, captures what the military likes about 2D bar codes.

> Two-dimensional codes combine the advantages of every data-entry method, including portability, readability, and excellent information-carrying capability, in a small area. Properly printed, they can have high readability if the correct scanner is used. Combined with error detection and correction, they can be quite secure. (LaMoreaux, 1996:58)

Smart Cards. The smart card is basically a computer without a monitor or a keyboard. It contains a central processing unit (CPU) and memory. The card is normally

read through contact with a reader. A more expensive alternative incorporates RF technology enabling the card to be accessed from a distance (AIM, 1999e).

Figure 9. **Smart Card** (AIM, 1999e)

The smart card represents a significant jump in technology over the bar codes. The cards holds about 16 KB and the data can be added, deleted, edited or rearranged (AIM, 1999e). The ability to edit the information on the card allows the card, unlike bar codes, to be updated or reused. Because of the CPU, the card is extremely flexible. The CPU enables the card to make logic decisions. This allows customized cards for individuals to grant or restrict access to secure areas. All this technology comes with several disadvantages. As would be expected, the card itself is considerably more expensive than a bar code. Additionally, because its use is not as widespread, the infrastructure and hardware costs are also more expensive. These prices can be expected to continue to drop as use increases. The other main concern is durability. Like any computer, it is vulnerable to environmental extremes (Watt and Smith, 1997:17).

Radio Frequency Identification (RFID). The last and most complicated technology is RFID. "Radio frequency identification (RFID) uses radio frequency (RF) transmissions to identify, categorize, locate, and track items" (Le, 1997:20). RFID first appeared during the 1980s in tracking and access applications. It was used in "hostile"

environments where bar codes were ineffective (AIM, 1999c). An RFID system contains two main components: a transponder and a reader. The transponder, otherwise known as a RF tag or just as a tag, attaches to the item being tracked. It stores the information about the item. As its name implies, the reader is capable of reading the information stored on the tag. It may be a hand-held or a stationary device (Le, 1997:20). Figure 10 shows the basic operation of an RFID system. "The reader emits energy that activates the tag. Information is then sent by radio frequency from the tag to the reader, which decodes the data before passing it along to a host computer for display" (Scan Tech, 1997).

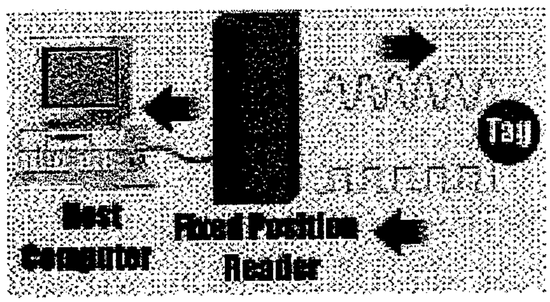


Figure 10. **RF Identification System** (AIM, 1999d)

Each tag is classified as either active or passive. Active tags have an internal battery that allows their signal to be read over greater distances. Their disadvantage is limited life span (about ten years) and increased cost. Passive tags get their power from the reader's signal. This gives them an unlimited life span but reduces their signal strength (AIM, 1999d). This requires the interrogator to be closer to the tag.

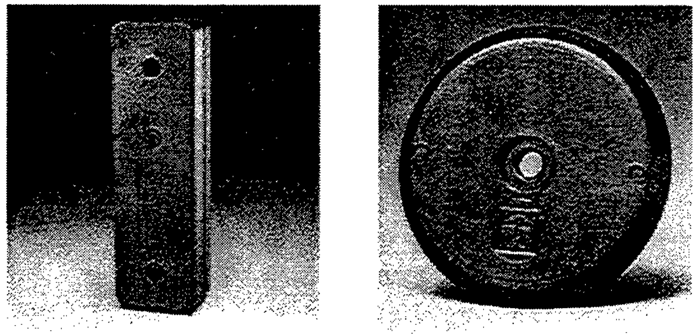


Figure 11. **RF Tags** (AIM, 1999d)

RF Tags operate in a wide range of frequencies (although any given tag operates on a single frequency). Each frequency has unique characteristics and is best suited for different tasks.

Table 4. **Radio Frequency Characteristics** (AIM, 1999d)

Frequency Band	**Characteristics**	**Typical Applications**
Low 100-500 kHZ	Short to medium read range Inexpensive Low reading speed	Access control Animal Identification Inventory Control
Intermediate (Medium) 10-15 MHz	Short to medium read range Potentially inexpensive Medium reading speed	Access control Smart cards
High 850-950 MHz 2.4-5.8 GHz	Long read range Expensive High reading speed	Railroad car monitoring Toll collection systems

Frequency deconfliction may be the biggest problem with RFID. Since many countries are protective of their RF spectrum, the process of seeking approval to operate an RF device can be complex and lengthy. Furthermore, each tag operates on only one frequency, so cargo movements through numerous countries around the world become extremely complicated. Another weakness of RF technology is interference from metal

objects. While tags work fine if they are dirty, wet, painted, or inside a non-metal box, they will not work inside of a metal container (Bower, 1994).

The area of standardization is an overarching concern for all the technologies. Chris Swindin, Technical Manager, Aim Europe, talks about the need for standards.

> Standards provide a common basis which manufacturers can rely on to produce products cost effectively – and users rely on just as much to ensure that what they are buying will perform satisfactorily. In the information technology area, standards are vital – when we are exchanging information between computers, compatibility is essential, or one man's data becomes another's goobledegook. (Aim, 1999f)

The RF industry is severely lacking in this arena. "Because no manufacturing standards exist, one manufacturer's equipment cannot read another manufacturer's tag" (Le, 1997:22). "Standards based on incompatible RFID systems exist for rail, truck, air traffic control and tolling authorities usage, as well as for the U.S. Intelligent Transportation System and the Department of Defense's Total Asset Visibility system" (AIM, 1999c).

But it is not just RF tags. The simple bar code has over 250 variations. There are dozens of 2D bar codes, fitting into three different symbologies. Some of which have no published standard (AIM, 1999a). Due to its joint nature, the military, more so than civilian industry, needs to be concerned with standards. If an Army's RF tag or bar code cannot be read by an Air Force scanner, the information will be lost. DoD has begun to identify standards for linear and 2D bar codes. "MIL-STD 1189B is the governing standard for bar coding in the DoD" (AFMC, 1999). Code 39 is being used for linear bar codes and PDF 417 (portable data format) is used for 2D bar codes (USTRANSCOM, 1997:1-9).

As shown in Table 5, each technology has strengths and weaknesses. The key for the Department of Defense is to use the three technologies in such a combination that the benefits of the strengths can be maximized while minimizing or negating the weaknesses.

Table 5 **AIT Strengths and Weaknesses** (Bower, 1994:141-143)

	Strength	Weakness
Bar Code	Simple and Proven Inexpensive Readily Available Minimal Infrastructure	Limited Storage Capacity Easily Damaged Susceptible to Environment Write Only Once
Smart Card	Logic/Intelligence High Data Storage Capacity Read/Write Capability Flexibility	Cost Sophisticated Hardware Minimal Existing Infrastructure Susceptible to Environment
RFID	No Line-of-Sight Requirement High Data Storage Capacity Read/Write Capability Provide Location of Item	Interference from Metal Cost Sophisticated Hardware Frequency Deconfliction

DoD's Intended Use

The Department of Defense understands the different characteristics and capabilities of each technology. This is evident in their decision to use the three different AIT devices. "Because no single AIT device can satisfy DoD's logistics requirements, the DoD needs to embrace a family of AIT devices" (DoD, 1997a). DoD capitalizes on these differences by choosing the right tool for the right job.

Linear bar codes are the most familiar form of AIT in use today. They can be used "to provide item identification and document control information for individual items and shipments" (USTRANSCOM, 1997:1-9). By limiting their use to individual items, the lack of data storage capacity is not a factor. Each bar code only needs to contain a simple part or stock number. Linear bar codes are widely used in commercial

industry. DoD can expect suppliers to be capable and well equipped to bar code their products. This is important since many of the military's supply items are of civilian origin. An increasing number of supply items are shipped by "direct vendor delivery" shipments which do not enter the military supply chain. The low cost and wide-spread use of linear bar codes make them ideally suited to the task of marking individual items. "Linear bar codes are used best as an automated key to pre-positioned data in a database" (DoD, 1997b:2-3).

Like the linear bar code, the 2D bar code can also be used to mark individual items. Because of its better durability and capacity, DoD intends to eventually replace linear bar codes with 2D bar codes. Until that happens, units and vendors must have the capability and tools to create both types of bar codes. The DoD favors the 2D bar code because of its increased data storage capacity (DoD, 1997a). This increased data enables the label to contain additional information beyond the part or stock number. "2D bar codes are used best in PDF 417 applications where the data needs to accompany an item and the bar code needs to be readable" (DoD, 1997b:2-4). The data could include who made the part, where and when the part was made, a word description of item, or even the delivery destination. If the item in question is a box or package, then the label would provide a tracking number, just like the linear bar code, but it would also be able to list the contents of the box. The label could also describe the planned transportation path the part will take through the DTS. The increased data storage of the 2D bar code gives DoD more flexibility. DoD continues to move towards using 2D bar codes to "provide comprehensive data on documents and individual items or shipments, and consolidation data on multipacks and air pallets" (USTRANSCOM, 1997:1-9).

There are two key differences between 2D bar codes and smart cards: increased data storage and write capability. These abilities enable the smart card to "provide quick and accurate entry of data to passenger and patient systems" (USTRANSCOM, 1997:1-9). Others have already dubbed these cards "deployment cards" because they can store large amounts of personal information such as name, assigned unit, destination, medical records, and shot records. They can also contain information about qualification and training levels for various systems. Furthermore, the smart card could be used to record every item issued during mobility processing, eliminating the need for written hand receipts. While not DoD's primary intended use, the cards could also be used to track important cargo shipments. The read/write capability allows each individual who processes the shipment to record the what, when, and where. This creates an excellent audit trail and establishes accountability. The smart card's flexibility allows management of large amounts of individualized data (DoD, 1997b: 2-5).

Radio Frequency Identification fills a niche that the other technologies cannot fill. It has the unique capability to be readable even when the tag is not visible. The DoD plans to take advantage of this fact. "RFID is used best when a user needs stand-off, in-the-box visibility of container contents or in an austere environment with an inadequate systems or communications infrastructure" (DoD, 1997b:2-6). Locating a specific container at a busy seaport represents a task ideally suited to RFID technology. Several major military seaports are being outfitted with RF sensors. These sensors can locate any container that might be needed. RFID is best used when a need exists to "see" inside a container. DoD intends to use RF tags "to support containerized ammunition, seavan containers,...and unit cargo moving in containers" (USTRANSCOM, 1997:1-9).

Table 6 summarizes DoD's proposed uses for each of the three technologies.

Table 6. **AIT Intended Uses** (DoD, 1997a)

Technology	Intended Use
Linear Bar Code	identify items and provide document control information for individual items and shipments
2D Bar Code	provide comprehensive data for documents, individual items, and shipments, and consolidation data for multipacks and air pallets
Smart Card	store personal and medical information for passenger manifesting and patient processing
RF Identification	support pallet shipments, seavan containers, ammunition and unit-cargo shipments moving in containers, movements of unit equipment, and pre-positioned cargo

Commercial-Off-The-Shelf Equipment

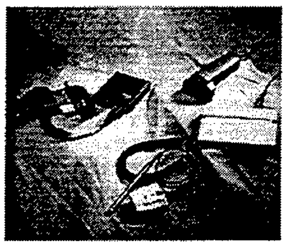
The purpose of this section is to provide a glimpse at some of the AIT equipment that is available today. It will not determine what equipment should be in the AIT fly-away kits. The products covered represent the type of equipment required to conduct AIT operations. The Air Force has an existing contract with Intermec Technologies Corporation for AIT equipment.

> The Automatic Identification Technology (AIT) contract is an Indefinite Delivery, Indefinite Quantity (IDIQ) contract. It provides a common baseline of bar code equipment, micro circuitry device, card technologies, software, and integration services to meet the needs of the DoD, the U.S. Coast Guard and other federal agencies. (Intermec, 1999a)

Even though the AIT is a growing industry and there are many companies manufacturing equipment, only Intermec products will be covered. If the USAF or DoD were to change

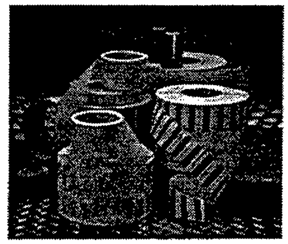
the contract in the future, it would be of little significance. All companies produce a similarly capable line of products. Figure 12 contains an overview of the Intermec product line.

Products & Services Solutions



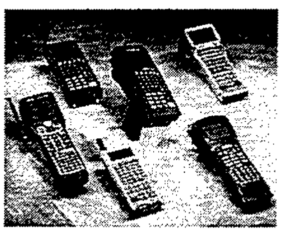
Data Capture Input Devices and Wedges

Intermec Technologies Corporation produces a wide variety of data collection equipment, including wands, badge scanners, imagers, charge coupled devices (CCDs), laser scanners and wedges.



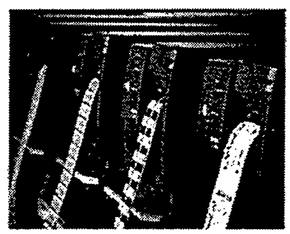
Label Supplies

Through Intermec Technologies Corporation's label, tag and ribbon manufacturing and distribution centers, we can equip customers with a label for every need, including those for extreme heat, cold, humidity or other harsh conditions.



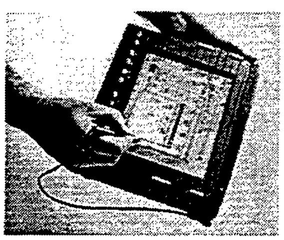
Local Area Data Management Systems

We offer a variety of hand-held, vehicle-mount, and stationary terminals, computers and network products to accommodate specific applications, host environments and bar code networks.



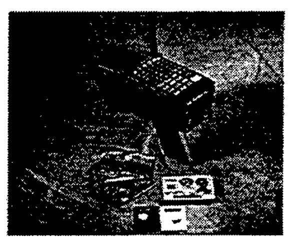
Printers

Our bar code direct thermal/ thermal transfer printer categories support light duty and specialty applications, as well as those for the most rugged environments.



Mobile Computing Systems

Our Norand Mobile systems PEN*KEY solutions combine the power of rugged handheld computers with application software and network management tools to support transportation, field service, utilities, route accounting, sales automation and other over the road applications.



Emerging Data Collection & Management Technologies

Whether it's smart cards for tracking personal records, RFID tags for tracking entire shipping manifests or other emerging data collection and management technologies, Intermec Technologies Corporation provides access and innovation.

RADIO INDEPENDENT™

Wireless LANs

We have the flexibility to equip customers with radio-independent wireless LANs that support UHF, 900 MHz, 2.4 GHz WLIF Open Air, IEEE 802.11 Frequency Hopping, IEEE 802.11 Direct Sequencing and future wireless technologies.

Service, Support & Partners

With every product comes a team of well-trained Intermec Technologies Corporation and business partner technicians ready to integrate our equipment into our customers' operations. We also offer follow-up service plans to ensure mission-critical business processes stay on track.

Figure 12. **Intermec Product Line** (Intermec, 1999b)

The use of bar codes, whether linear or 2D, requires two main pieces of equipment. A reader for scanning bar codes and a printer for creating bar codes. Readers come in many different shapes and sizes. Three different reader models and one printer are shown in Figure 13.

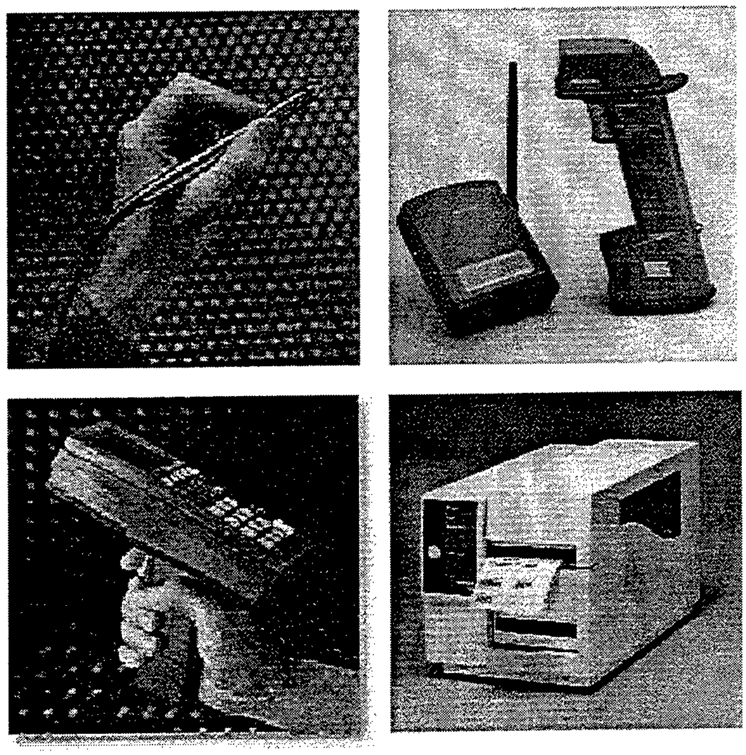


Figure 13. **Bar Code Equipment** (Intermec, 1999f)

The upper left picture shows a digital wand scanner. Wands are smaller and lighter than most other scanners but can be more difficult to operate. The label will not be read if the wand does not move across it at the right speed. The cord on this wand needs to be connected to a computer. In the upper right is a cordless, laser scanner. The laser scanners allow for labels to be read without moving the scanner. The receiver unit is connected to the computer system. The cordless scanner can operate up to 50 feet from the receiver and one receiver can handle nine separate scanners at once. The lower left

corner shows the most sophisticated of the three scanners. It is a laser scanner with built-in computing power. It can function as a stand alone unit or tie into the computer system with built-in RF communications. The last picture represents a typical bar code printer. Special software is required to design, code, and print the labels. The labels can be printed on a variety of paper types (Intermec, 1999f).

Smart cards require one piece of equipment, a combination reader/writer. The equipment is compact and connects easily to a computer. Figure 14 shows pictures of both internal (left) and external (right) models.

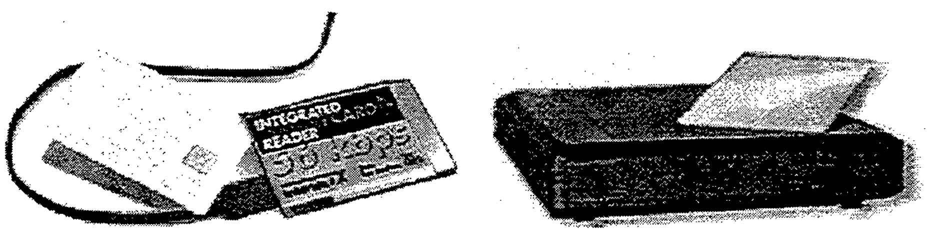


Figure 14. **Smart Card Equipment** (Intertex, 1999)

The internal model is nothing more than a PC Card that slides into the side of the laptop. The external model connects to a PS/2 port on the back of the computer. Smart cards are inserted one at a time into a special slot on each device. Once the card is inserted in either device, data can be read and/or written. Special software is required to interpret and write the data. (Intermec, 1999d)

Of the three technologies, RFID capability requires the most complicated equipment. In the simplest sense, like smart cards, both a reader and a writer are required. The antenna in the upper left of Figure 15 mounts on a tall pole, to improve coverage, and sends and receives signals to communicate with the tags. This type of antenna is not capable of writing to a tag. To complete the package a programmer or

writer, lower left corner, is required. The tag is placed on top of the programmer before attaching the tag to the item. The picture in the upper right corner is a different type of reader (with several tags in the foreground). The picture below it, shows what is inside. It is designed to read tags as they move past at speeds up to 80 mph. All the antennas and programmers need to be connected to the computer system and supported by special software. The connection can be physical (i.e., cable) or by RF communication. If large distances are being covered, repeaters are necessary to boost the signal and ensure coverage (Intermec, 1999c).

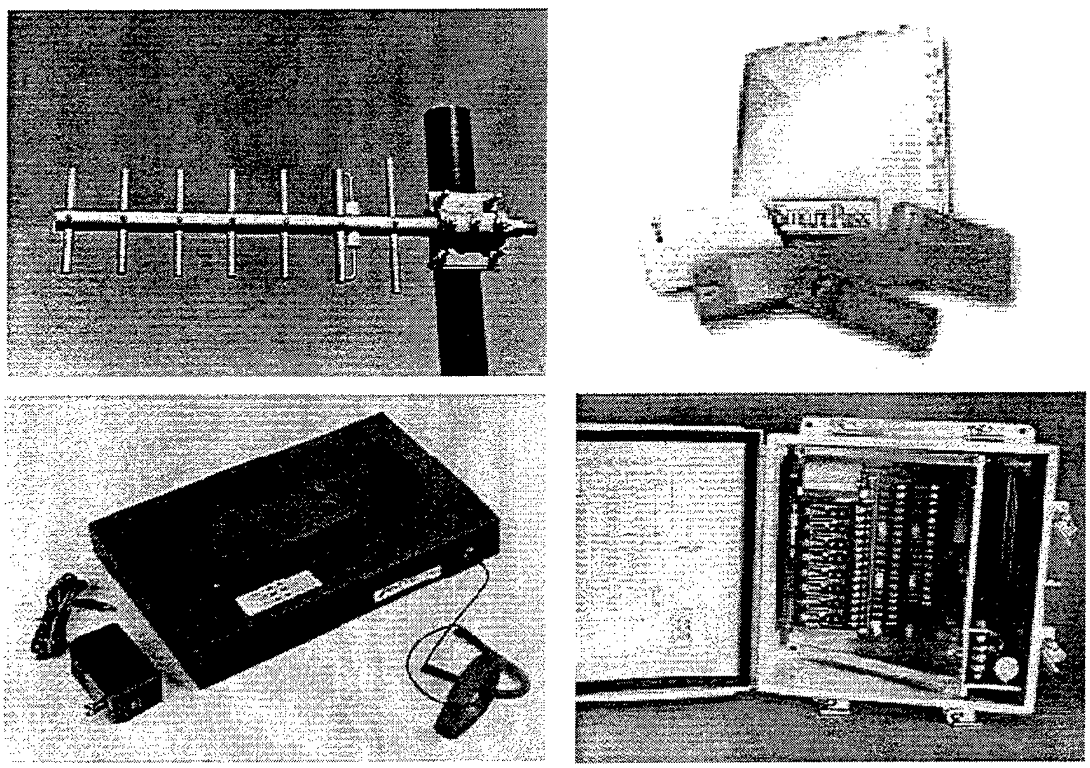


Figure 15. **RFID Equipment** (Intermec, 1999c)

These products are a small fraction of the AIT equipment available today but represent the many different products on the market.

Conclusion

> AIT includes a variety of methods for marking or "tagging" unit equipment, containers, or individual items. Shipments can be tagged with bar codes, magnetic stripes, smart cards, optical laser cards, or magnetic storage media with built-in transmitters and receivers. The information on each tag can range, for example, from just a commercial container number to details on every item within a container. (Snyder and Guilliams, 1995:iii)

Much information is available about the different technologies and their characteristics. Table 7 is formatted to "provide general information about the AIT media and to make a general comparison of the AIT media with reference to their various functional capabilities" (Bower, 1994:96).

Table 7. **AIT Functional Capability Matrix** (Bower, 1994:97)

Functional Capability Attributes N = Not Required R= Required 1 — 2 — 3 Low — Average — High Capability/Desirability	Bar Coding	Magnetic Stripe	Smart Card	RF/ID	Optical Card
Applicability (for various applications)	3	3	3	3	3
Data Storage Capacity	2	1	2	2	3
Ease of Use	3	3	3	3	
Electromagnetic Interference (EMI)	3	1	1	3	3
Error Detection (transmission/reception)	3		3	3	3
Flexibility (for various applications)	2	3	3	3	3
Growth Potential/Expandability	3	3	3	3	3
Line of Sight Requirement	R	R	R	N	R
Logic/Decision Making Capability (on the card)	1	1	3	1	1
Mechanical Device Contact for Read/Write Operation (direct)	3	1	1	3	3
Interactive Operation (for decentralized database use)	1	1	3	3	3
Passive Operation (for centralized database use)	3	3	3	3	3
Security Features Available (physical, built-in)	1	1	3	3	3
Audit Trail Capability	1	1	3		3
Information Security (resistance to duplication, counterfeit, tamper)	1	1	3	3	3
Survivability (durability to various environmental conditions)	1	1	1	3	3

Based on these characteristics, DoD has identified specific uses for each technology. Linear and 2D bar codes identify individual items. Linear bar codes contain only a part or tracking number. The increased data capability of 2D bar codes enable the collection of not only part numbers but also descriptions and instructions. The smart card will be used to store personal information for each individual. Primary uses will be manifesting passengers and admitting patients. RF tags track pallets or containers of items. This avoids breaking down a pallet or opening a container to determine its contents.

Each technology requires unique equipment for proper operation. But, in general, all require a reader, a writer, special software, and a connection to a computer system. The benefits of any AIT system "are elimination of clerical errors in recording data, faster data collection, and a reduction in labor and paperwork required to process data" (AIM, 1999a). The key is to mold the different technologies and equipment into a total package that works for the Defense Transportation System and ITV.

IV. AIT Scenarios

Introduction

Automatic identification technology may be an emerging technology; but it is certainly not untested in the civilian sector. For instance, bar codes have been used in grocery stores for many years. Even RFID has been used frequently over the last five to ten years. For example, Asian ports use RFID to track all of their containers. "Transponders are embedded into the ground throughout the port. When cranes hoist cargo on and off ships and trucks, the lifting arm-mounted readers interrogate each transponder and match the code with the yard location" (Le, 1997:22). This enables managers to know exactly where containers are and what they contain. Information about the container contents is forwarded to customs to expedite the processing (Le, 1997:22).

Neither is AIT untested in the military. Just as with the civilian sector, bar codes seem to be everywhere in the military. Over fifteen years ago, the Joint Financial Management Improvement Program produced a paper that examined the feasibility of using bar codes to improve efficiency and control (JFMIP, 1982). In 1995, Captain Gary Gross wrote an AFIT thesis on tracking pallets with RF tags (Gross, 1995). Both the Air Force Academy and West Point issue smart cards to each student. These cards contain bar codes and microprocessor chips to "allow for paperless and cashless transactions for the cadets, as well as ready access to personnel information" (SRC, 1999). Finally, the Army uses a system called Wildcat to track and manage repair parts (Intermec, 1999f).

Numerous other AIT applications are being tested in the military today. To learn and gather information about AIT and ITV, the military monitors visibility during selected exercises and deployments. This chapter begins with a discussion of how smart cards are being tested in the Pacific theater. It then reviews USTRANSCOM's unit move scenario implemented in Europe. The chapter ends with a discussion of the possible future uses of AIT and lessons learned from past trials.

United States Pacific Command

USPACOM created the Oahu Working Group (OWG) to handle, coordinate, and oversee smart card issues in the Pacific theater. The first major use of the smart card was in December of 1994. USTRANSCOM used them to track 3,600 Army soldiers as they moved from Hawaii to Haiti. Each soldier received a Multi-Technology Automatic Reader Card (MARC) or smart card. The goal was automated manifesting and personnel accountability.

> When service members from the 25th [Infantry Division] board aircraft destined for Haiti, their cards, which contain personnel data, are passed through a reader (swiped) and entered into the aerial port system which in turn feeds the information into GTN. From that moment on, their whereabouts can be tracked at any given time. It now takes hours to process more than 400 service members on a 747 aircraft, but with the MARC cards tied into GTN the goal is reduce that time to minutes. (USTRANSCOM, 1995)

Additionally, the number of personnel required to support the manifesting process was reduced from 15 to 7 (Watt & Smith, 1997:43). The use of smart cards saved time and personnel as well as reducing errors. During COBRA GOLD 98, smart cards were once again used to manifest passengers. Soldiers were checked in at the amazing rate of seven

seconds per passenger; instead of hours, the check in process took minutes (Matthews, 1999:18). The exercise validated USTRANSCOM's goal of automated manifesting.

The smart cards have also proven beneficial during deployment processing. "Cardboard folders full of paper documents, which troops typically carry with them during deployment processing, will become obsolete." No longer do processing personnel have to search through reams of paper in a box. Once the deploying member's card is inserted in the reader, all the information displays on the computer screen. The information can be deleted or updated and then written back to the card. The 25th Infantry Division used smart cards to process 1000 soldiers in approximately 4 hours. Without smart cards, it normally takes 12 hours to process 400 troops. "The Marines use Smart Cards to keep close track of weapons and other gear checked out during training." The Defense Manpower Data Center will make recommendations to the Pentagon this fall after issuing 100,000 smart cards to the Navy and Marines (Matthews, 1999:18).

United States European Command

To test other AIT technologies, USTRANSCOM developed four AIT prototype scenarios. The tests are being conducted in the European theater. The prototypes mainly test 2D bar codes, RF tags, and satellite tracking. The Air Cargo Scenario covers two airlift channel missions from the United States to Europe. It focuses on the use of RF tags for consolidation and deconsolidation of cargo at aerial ports. The Ocean Move Scenario covers two cargo channels as well. Commercial ocean carriers have agreed to allow their containers to be tagged and RF readers installed at the terminals. The third scenario is the Unit Move Scenario. It tracks the redeployment of troops and their

equipment from Bosnia to Fort Polk. The focus is on AIT operations at austere locations using satellite links. The last scenario tracks ammunition from Crane Depot in Indiana to Europe. This is a paperless intermodal operation and is awaiting execution (Kelly, 1998).

When the scenarios were developed, General Kross had three objectives he hoped to accomplish. First, "determine which AIT media work best in our air and ocean ports, considering all systems and processes they touch throughout the logistics pipeline." He foresaw widespread use of 2D bar codes and RF tags. His second goal was to "determine which AIT solutions are cost efficient and can help our business process." General Kross' last objective was to "validate a set of very tough but very necessary new data timeline standards." His bottom line, "we're looking for answers to simple questions: what works, what doesn't work, what works but costs too much" (Kross, 1998). This section limits its focus to the unit move scenario.

The unit move scenario highlights the need for integrated and standardized AIT. It involves three unified commands, five automated information systems (AIS), three PODs, multiple modes of travel (rail, bus, truck, barge, ship, plane), and all three different AIT technologies. Figure 16 shows all these interactions. While the scenario was ongoing, LTC Layer provided this description.

> The 2nd Armored Calvary Regiment (ACR) redeployed from Bosnia over a six week period beginning 6 June 98. Unit equipment moved by rail from Bosnia to the Port of Bremerhaven where it is staged and waiting for allocated sealift. Unit aircraft self-deployed to Coleman Barracks for movement preparation. From there, they were moved by barge to the Port of Rotterdam. 2nd ACR soldiers departed base camps by bus and traveled to Taszar, Hungary where they boarded aircraft for Fort Polk. Unit equipment will sail to Port of Beaumont and arrive in mid-Aug 98. The 2nd ACR will line haul equipment back to Fort Polk at that time. (Layer, 1998)

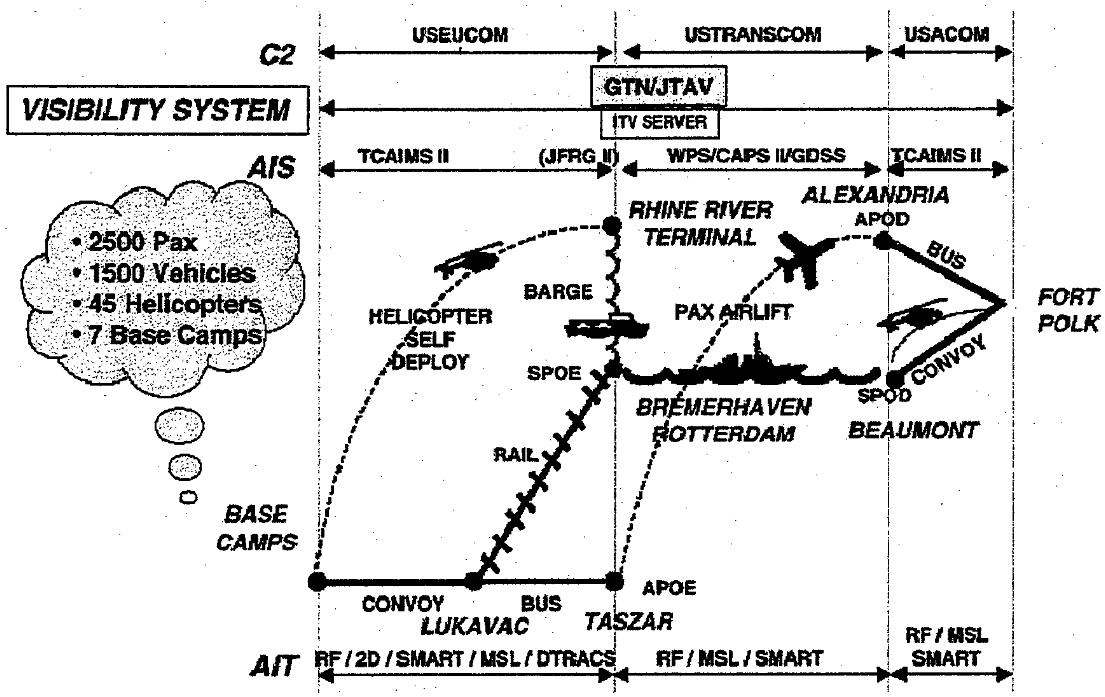


Figure 16. **Overview of Unit Move Scenario** (Cordell, 1998a)

All three of the AIT technologies were used to ensure intransit visibility during the redeployment. Smart cards were used to manifest passenger much like the way they were used in the Pacific theater. By coupling the manifesting with an AIS that fed GTN, users were able to access data on every soldier's location. 2D bar codes were used to improve the standard military shipping label (MSL). The increased data capacity of the new 2D MSL eliminated the need to manually add data to the AIS as the items moved toward Fort Polk. RF tags were the biggest part of the scenario. "Radio frequency tags were applied to all unit containers, artillery pieces and helicopters." The RF tags provided automatic visibility on the high value items as they moved through the ports. The RF tags on the containers eliminated the need to manually input the data into the AIS. They also provided "in-the-box" visibility for the contents of the containers. This data is accessible by "drilling down" using GTN. The scenario also used the Defense

Tracking and Control System (DTRACS), a technology not addressed in this paper. This is a satellite tracking system which provides real-time location data on convoys. It also provides satellite voice communication for the drivers. The system allowed for superb visibility of high value assets moving by convoy. The unit move scenario showed that AIT could be used effectively to get data into the information systems. Once the data in the AIS is accurate ITV is ensured (Layer, 1998).

The Future?

Future uses for AIT are almost infinite. Technology will continue to become more powerful and less expensive. The real challenge is recognizing where AIT will be beneficial. For instance, Rita Le describes RFID as much more than simply a device to track an item's location or contents - it provides cradle to grave information:

> The tag will be used during manufacturing for detailing options and specifications; act as a tracking device during shipping; prevent shoplifting or theft by inclusion of a photo sensor; include instructions on use; update inventory records at the point of sale; and finally provide disposition instructions. In other words, one day these tags will cover the logistics spectrum (Le, 1997:22-23).

In a similar vein, Bert Moore creates the scenario where AIT is used to automate the process.

> Now, imagine receiving truckloads of material that automatically "tell" your receiving software what it is (without having to scan it). Imagine having a shipping system that automatically records everything that goes onto a pallet and then automatically generates the shipping manifest and stores it on an RFID tag. Imagine having access to complete product information and shipment data in off-line situations or remote locations. (Moore, 1998:26)

The future holds many possible scenarios, each with multiple solutions. Randtec, Incorporated is just one company developing a line of products for the future. Their

slogan is: "A world of solutions for transportation and distribution ™." They start with RF tags installed on trailers, tractors, and dollies to provide real time monitoring. Gates automatically open and close based on the information in the tag. At the same time, the system records trailer departures and arrivals. Computers are installed in the tractors and on the docks providing information to everyone. Drivers and supervisors can see where trucks are supposed to go. Additionally, as trucks move, the system is updated in real time. "The *Ultra*YARD ™ system ensures the delivery of the right trailer to the right location at the right time." To compliment *Ultra*YARD, there is *Ultra*DOCK ™. *Ultra*DOCK provides the same kind of real-time information for inside the warehouse. Forklifts are tagged to track their movement and location. Randtec even produces a product that monitors trailer loading and unloading.

> *Ultra*CUBE ™ ultrasonically determines when trailers are empty, one-third full, two-thirds full, or full. Additionally *Ultra*CUBE reports door status and whether or not a trailer is tethered to a tractor. An optional temperature measurement function is available. The very low profile *Ultra*CUBE mounts easily in the middle of the ceiling in 28 to 57 foot long trailers. Addition of any cargo is recognized within 30 seconds.

To tie everything together there is *Ultra*LINK ™. *Ultra*LINK runs on a Windows® 95/NT® platform and communicates with the readers over a wireless network. Users are able to store detailed asset information in a database. The software produces customizable reports to track assets. Used together, these systems provide seamless movement of cargo (Randtec, 1999).

Lessons Learned

Although the examples covered in this chapter come from two different theaters and several scenarios, several common lessons learned can be identified. The following provides a discussion of both tactical and strategic lessons learned.

In general, tactical concerns deal with the day-to-day operational processes. For example, one of the problems in Europe was the poor quality of 2D bar code labels. The lesson learned from this experience is that the responsibility for producing quality bar codes begins with the source provider. Another problem with bar codes arose during direct vendor deliveries (DVD). Many of the DVD did not have bar codes (Cordell, 1999b). The lesson learned is that commercial suppliers must be integrated into the AIT plan. Further, as mentioned in chapter three, frequencies for RF tags turned out to be a major problem, so detailed power, communications and frequency planning is imperative (Cordell, 1998b). Lastly, all the AIT equipment is technical and the best source of technical expertise is the contractor (Cordell, 1998b).

Strategic issues are more encompassing than tactical issues. Solutions tend to involve many people and require support from upper management. The first strategic issue learned was to integrate AIT into the planning process. For instance, all the time saved processing passengers with smart cards was lost due to poor planning. The planners assumed it would take the normal length of time to manifest passengers, so the plane was scheduled to depart several hours after the passengers were ready (Matthews, 1999). Another lesson learned involved the overall lack of training. Not just training for those in the field using the AIT equipment, but also the commanders trying to use computers to locate their equipment (Cordell, 1998b). These lessons suggest that

everyone at all levels must be involved. Lack of adequate planning, training, and integration at all levels will diminish the benefits of AIT.

Possibly the most important lesson learned is a positive one: AIT works. It did improve ITV. And most importantly, "this enhanced ITV significantly improves the CINC's ability to track and shift forces during a deployment" (Layer, 1998).

Conclusion

There are many more examples that could be examined but the USPACOM and USEUCOM scenarios are good representative samples. They include all three of the AIT technologies and various modes of travel. All the scenarios exposed some common lessons learned. The tactical level issues will be worked out over time by hard working individuals. It is the strategic changes that need to be addressed by top leaders. The following quote states the importance of the strategic level changes.

> Electronic data management provides companies with many opportunities for using instantaneous information exchanges to reduce the time and cost associated with information transfer and processing. These technologies create additional schedule and cost benefits by making it possible to eliminate activities or tasks that no longer add value in an automated, integrated information environment. Corporate efforts to dramatically, perhaps even radically, restructure an entire process to exploit opportunities created by electronic technology are a form of reengineering frequently undertaken by companies that wish to explore the full potential of electronic data management. Strategic advantage can be attained, not from the benefits attributable to the technologies themselves, but rather from the significant changes they create in organizational structures, interorganizational processes, and corporate policies and procedures. (Back and Bell, 1996)

In other words, it is not the AIT technology that will provide great improvements in ITV. The biggest benefits come from changing the processes and rules of how

business is done. The chapter closes with an example that shows the type of reengineering that needs to happen.

> Just think how much time has been saved from standing in checkout counter lines by simply scanning bar codes. Now think how much additional time would be saved if one did not have to unload groceries at the checkout counter at all. What if shoppers simply pushed loaded carts through a special exit that tallied the total price of all items in a matter of seconds, and, at the same time, inventory data was updated and other management information collected by a small electronic reader? (Le: 1997:20)

V. Discussion and Conclusion

Introduction

As the Department of Defense redefines its role in the post Cold-War era, the efficient use of limited airlift assets becomes more crucial than ever. Both material and manpower are wasted by unnecessarily shipping redundant equipment. Tracking assets while intransit provides the information required to make informed decisions. Unfortunately, "manual data entry is labor intensive, time consuming, and prone to errors" (USTRANSCOM, 1997:3-29). These characteristics are in direct conflict with what is described next:

> As the Air Force moves toward the 21st century, future military operations will likely involve quick responses to remote locations. Therefore, improved ITV systems will have to rely on fewer people while providing better ITV information in order to meet the continuing challenges and demands of the current military strategy. (Wolford, 1996:14)

Even the commercial sector agrees with the importance of easy data collection processes. "In logistics systems, data is the tool that makes the system work. The key to good data is collecting and communicating it automatically" (Burnell, 1998:42). Automatic identification technology provides the necessary capabilities. "AIDC systems improve businesses in three ways: inexpensive data entry, increased information availability, and near perfect accuracy" (AIM, 1999b).

This chapter discusses the application of automatic identification technology at remote locations to obtain ITV information. The three investigative questions are reviewed first, providing the building blocks to answer the research question. AIT's

impact will be discussed within the framework of four distinct categories: process, training, manning, and equipment.

Review of Investigative Questions

How does AMC currently capture ITV data at remote locations? As noted in the AMMP, the current processes for mobility information gathering and management are complicated. Consequently, the physical act of data capturing is difficult to describe. The responsibility rests with the ITV team members who generally do whatever it takes to obtain ITV information. When users provide the required information, it is simply a matter of electronically transferring and converting the data. Errors occur when no electronic data is available and the team must manually enter the information. The most time-intensive operations occur when the user provides incomplete information. Before the data can be entered, the missing data must be tracked down by the team.

Teams normally consist of three 2T2XX personnel. One is the system administrator responsible for setting up the computer network and the other two are cargo or passenger specialists. All are versed in the workings of RCAPS for manifesting passengers and cargo. Current tasking calls for 100 of these teams.

Training responsibility is divided between base level units and the Air Mobility Warfare Center (AMWC). The AMWC offers a five-day system administrator course. Training for the other two team members is conducted informally by their units.

Finally, the equipment required for these teams is extensive (see Appendices B and C). Teams normally deploy with three computers, a printer, and many cables. AMC

is working on documentation that details how to collect ITV data and expects release in June 1999.

What automatic identification technologies and products are currently available? Automatic identification technology is constantly evolving and improving. To establish some standards and focus their efforts, the DoD decided on three technologies to pursue: 2D bar codes, smart cards, and radio frequency identification. Based on each technology's specific characteristics, intended uses were identified. Low cost and ease of use make the 2D bar code ideally suited for tagging individual items. Its data capacity permits the storage of comprehensive documentation which is needed at remote locations without access to an information database. Smart cards possess two key characteristics: high data storage capacity and read/write capability. The DoD plans to use smart cards for storing personnel information. The on-card microprocessor provides flexibility for data manipulation. Finally, RFID is used for tagging pallets and containers. Its extensive data capacity allows the tag to store information on the containers contents. Moreover, the tags do not require line-of-sight to be read.

What lessons have been learned by other military commands and civilian organizations employing AIT? The good news is that AIT works. 2D bar codes increase data accuracy by eliminating human errors that occur when manually entering data. Smart cards drastically reduce time and manpower requirements for processing and manifesting passengers. RFID increases visibility by populating GTN with drillable cargo data. However, there are areas identified that need improvement. For instance, the quality of 2D bar codes requires improvement and direct vendor deliveries must have bar codes. Availability of limited RF frequencies will continue to pose a problem and lack of

training is definitely a primary concern. Further, on a larger scale, AIT must be incorporated into the planning of exercises and deployments. Finally, the biggest improvements may not come from the technology but from changing processes.

Application of AIT at Remote Locations

This section examines the application of AIT for ITV at remote locations. Four distinct areas will be addressed: current processes, training programs, manning requirements, and equipment lists.

Process. Recent exercises have certainly shown that AIT can streamline the ITV data collection process. However, AIT technology in and of itself will not simplify the current procedures. It is the forced compliance that creates the benefits. The AMMP points out that "deploying or redeploying units are not always fully prepared with the documentation they need to move" (AMC, 1997:4-48). If units currently do not show up with the required data, there is no expectation that they will show up with their equipment properly tagged with AIT. If the deployed ITV team must create all the AIT tags, the process becomes time intensive and error prone once again. All the time and accuracy benefits of AIT are lost if the user is not prepared. The key is to force the user to be prepared. In fact, even currently, if the user showed up with all the information required by MILSTAMP, it is no problem to manually input the data. The real work begins when searching for missing or incorrect data (Norwood, 1999). Standards will prove to be more important than they are today with manual data entry. AIT does not allow for the human intervention and interpretation that can occur when manually entering data. The tag must be read and interpreted correctly by a computer. If an Army 2D bar code, smart

card, or RF tag cannot be read and properly interpreted by Air Force readers, AIT provides no benefits. Automatic identification technology has the potential to positively impact the current ITV processes. It can provide more accurate data in shorter time periods but the user must be properly prepared.

Training. The application of AIT will require increased training. Until AIT is fully integrated and matured, team members will still require manual-data-entry skills. This means no relief from the current training requirement. Additional training is required for the AIT equipment. Training will focus on both the hardware and the software requirements of AIT. From the hardware aspect, team members must be trained on how to physically use the various reading devices. Additionally, training is required for the integration of the AIT devices with the computer network. RF systems require the installation of antennas and readers.

Computer software is the second area requiring new training. There is unique software for creating and printing 2D bar code labels with which the team must be proficient. Similarly, reading and writing data to smart cards and RF tags requires new and separate software programs.

Lessons learned from previous AIT experiences have shown that the best source for information sytem expertise is the contractors themselves. However, contractors may be an unreasonable solution considering the remoteness of some operating locations. For now, integrating AIT will definitely increase the training required for team members. Once AIT usage matures, it may be possible to eliminate manual-data-entry training requirements.

Manning. The application of AIT will not affect the current manning requirements. It will increase the capability of the ITV team; but AIT does not reduce the requirement for the three-person team. A system administrator will always be required to setup and maintain the computer network. Currently one team member is a passenger specialist and the other is a cargo specialist. This is required because the data to be entered and the computer software is totally different. Theoretically, using AIT there is no need to have specialists since no manual handling of the data is required. Unfortunately, the user is not always prepared. Eliminating one of the two data entry personnel would severely handicap the operation if the AIT equipment could not be used for some reason. Also, having two members collecting data provides flexibility. The cargo will most likely be scanned at the airplane. The passengers may be processing at the terminal. Having two data collection personnel allows for both of these processes to happen simultaneously. Currently the three person teams can handle a MOG of two airplanes. It has been shown that AIT reduces processing. Therefore, it would be reasonable to expect a three-member team to be able to handle a MOG of greater than two. Again, this new capacity is based on all AIT systems functioning and being used. Integrating AIT would increase the team's throughput capability but would not decrease the size of the team.

Equipment. Integrating AIT will have a big impact on the equipment required for collecting remote ITV. Table 8 contains the equipment list developed by USEUCOM for an AIT fly-away kit. The contents of the kit are designed to outfit a remote or austere airfield.

Table 8. **AIT Fly-Away Kit Contents** (Cordell, 1999a)

Equipment	Quantity
Laptops (for JTAV & GTN)	1
Intermec Codewriter 3200 or 3240 Printer	2
HPLJ6 Printer	2
Dot Matrix Printers (multi-part forms)	2
Laptops (for TC AIMS II)	2
Misc Cables/Antennas	2
Lan Hardware/Software	1
Savi Fixed Interrogator v3.0 (SR-410R-006)	3
Savi Retriever (CS-1010MU)	2
Tripod (ACC1105)	3
Mounting Kit (SRA1001)	3
Cables for Fly Away Kit	3
Savi Docking Station (SDS-1001)	2
RF Tags	100
Smart Initialization Unit	1
Smart Card Reader, PCMCIA	2
Smart Card	100
DTRACS Mobile Dispatch Station	1
DTRACS Mobile Units	4
AMS Rapid Deployment Unit	1
INMARSAT "C" (data only)	1
INMARSAT "M" Mini (Voice capable)	1
Portable Generators	2
UPS Support	3
RF Links, 2.45 GHz (RFR-200)	2
RF Modem Mounting Kit	2
JR2020 (2d, 3 of 9, RF-ID capable)	4

Much like the current kits, this kit contains three laptops and the necessary cables for crating the network. Additionally, the kit contains all the equipment for creating and reading each of the AIT technologies. There are extra printers for supporting the creation of bar codes. The JR2020s are cordless bar code scanners. They require the RF modems for linking with the laptops. There are also smart card readers that plug into the computer and a multitude of RF interrogation equipment. This kit includes the INMARSAT radios to provide voice and data linkage from any site. The kit also contains the DTRACS

equipment to provide satellite tracking. Notice also, the requirement to carry blank AIT media (100 smart cards and 100 RF tags). All the contents of this kit may not be required for every remote location.

Wireless AIT devices must be connected to a wireless LAN to maximize the benefits of such devices. "Wireless technologies such as radio frequency, satellites, lasers, and mobile computers remove the restrictions that wires and cables place on an industry that's all about movement" (Hayes, 1998). Figure 17 shows the layout for a typical wireless LAN. The individual laptops use modems to communicate with the access points that connect to the server.

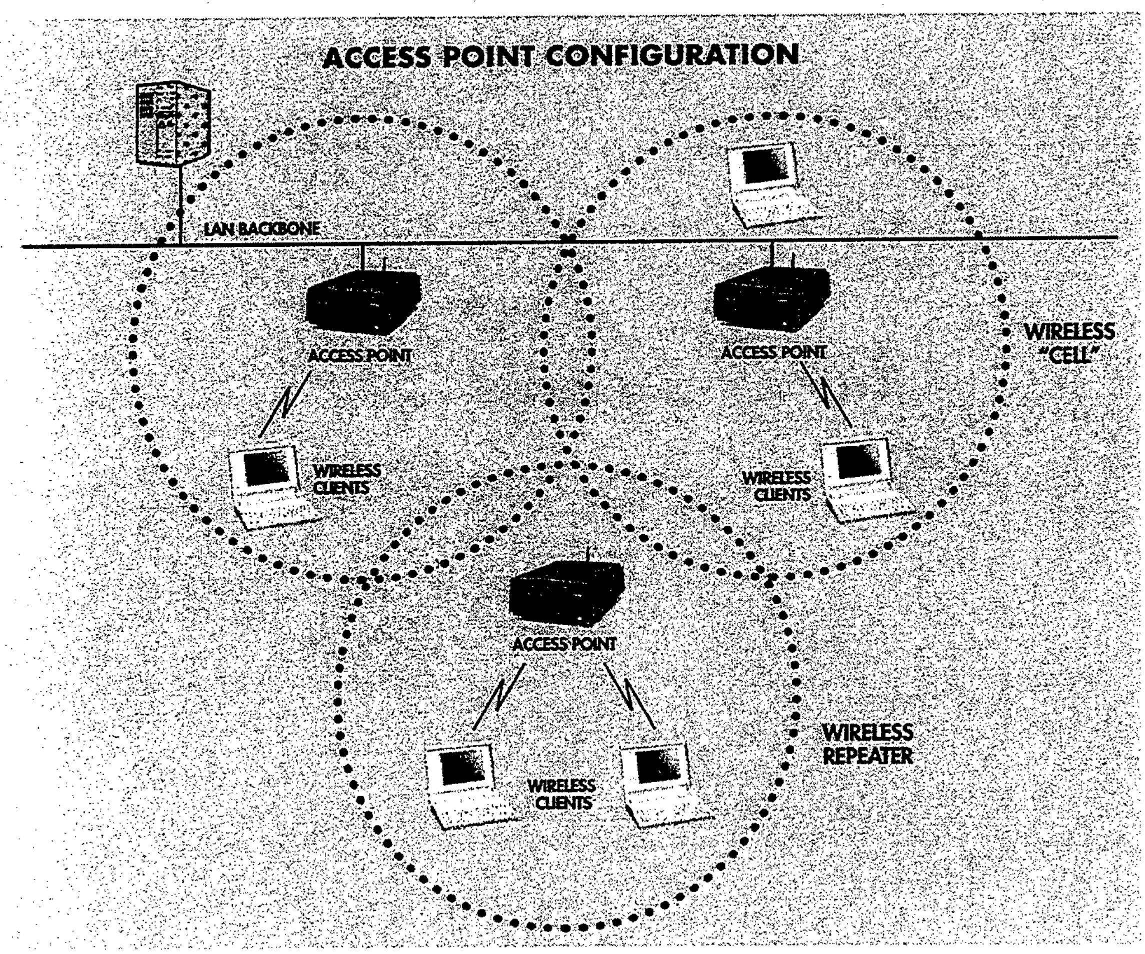


Figure 17. **Wireless LAN Layout** (Intermec, 1999g)

Figure 18 shows both types of equipment. The wireless LAN does not require any more hardware than the current kits, just different hardware. This technology allows for the laptops to be moved wherever the data collection is required.

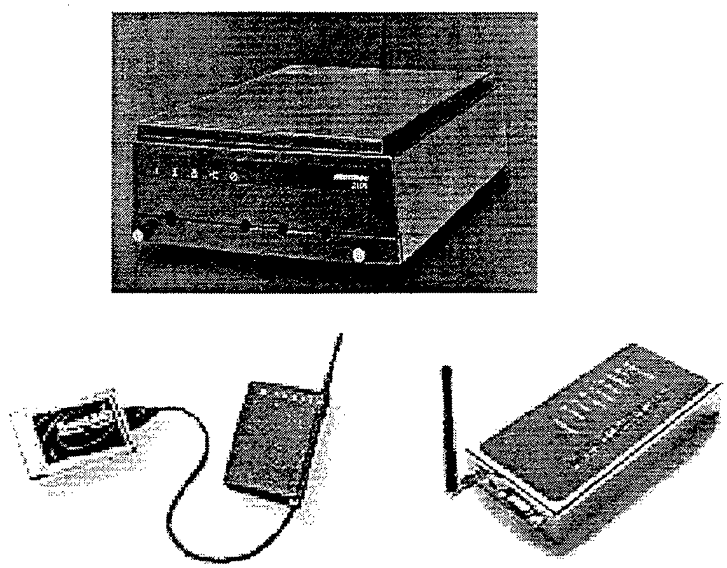


Figure 18. **Wireless LAN Equipment** (Intermec, 1999g)

Integrating AIT requires more equipment. The general requirements for the LAN are the same; but additional equipment is required for reading and writing bar codes, smart cards, and RF tags.

Conclusion

History has shown the impact of poor intransit visibility. Frank Weber from USTRANSCOM, during a presentation to the Transportation Research Board, linked ITV with lives.

> Unless and until we improve our ability to exchange accurate data in real time, we will reach a point of diminishing returns on our infrastructure and modal investments. Information is time and, as I said earlier, time is money to you (industry). Time is lives to DoD. (Weber, 1997:81)

Automatic identification technology can provide accurate and current information on passengers and cargo in the DTS. This paper examined the application of AIT for capturing ITV data at remote or austere locations. It covered four areas: process, training, manning, and equipment.

AMC's current remote location processes are daunting. AIT is capable of simplifying these procedures only if users are properly prepared. Past exercises have shown that cargo with bar codes or RF tags and passengers with smart cards can be processed quicker and with less manpower. Unfortunately, if the user does not have the cargo or passengers ready, the processes revert back to current levels. Training for the user on how to prepare material for shipment is important. Additional training for ITV team members is also required. The setup and use of AIT equipment requires technical information that is currently not taught. The successful application of AIT depends on adequate training at all levels.

Manning requirements will remain unchanged with the application of AIT. The current three-member team provides flexibility and allows for manual data entry if necessary. That being said, if users are properly prepared, the team should be able to significantly increase their throughput capacity while realizing big improvements in data accuracy. This increased capability requires additional equipment. Each of the three technologies: 2D bar codes, smart cards, and RF tags, require specialized equipment for reading and writing information. Blank RF tags and smart cards, as well as special paper for bar codes, needs to be available. The addition of a wireless LAN increases flexibility and is required to reap all the benefits of AIT.

There is no doubt that automatic identification technology can improve the ITV process at remote locations. As USTRANSCOM and AMC move forward to make AIT a reality, there are two concepts that cannot be lost. First, technology is not the answer to every problem. Second, intransit visibility is just one third of the DoD goal of total asset visibility.

> Any manager must always be careful not to fall into a preconceived-notion trap. Just because someone says that a barcode system is needed, it does not mean that it will be the right solution. Organizations tend to look at what is currently in vogue, the current fad or what is on everyone's mind: "If everyone is going to barcodes, we should." Or "I heard a great speaker on automating the plant; we must do that." This can easily divert attention away from the true problems. (LaMoreaux, 1996:228)

One must remember that technology does not provide the biggest gains. The biggest gains come from reengineering processes. Many of these changes are made possible by technology, but one should not focus solely on the technology. For example, accurate, real-time ITV may allow for a change in the way forces deploy. "Industry is leading the way in just-in-time delivery concepts, merging the manufacturing and transportation systems in ways never before envisioned. In the DoD, the demands of today's and tomorrow's warfighting strategies mandate just-in-time force delivery and sustainment." This is a radical shift from the "just-in-case" approach used in the past (Weber, 1997:80). This just-in-time delivery may be the wave of the future but it is bound to be lost if the focus is solely on improving ITV. Notice in Figure 19, from Joint Vision 2010, that to obtain full spectrum dominance, advanced technologies are used to make organizational changes.

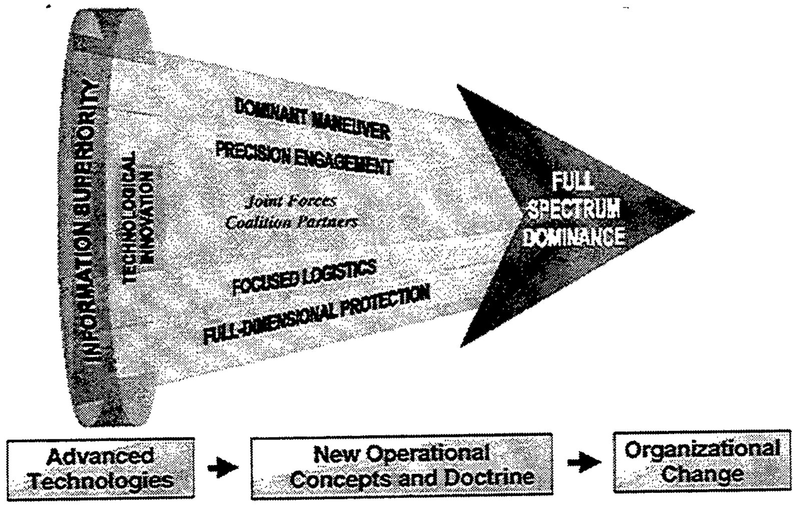


Figure 19. **Full Spectrum Dominance** (CJCS, 1997:26)

Figure 20 shows how intransit visibility fits in the total asset visibility picture. Notice the link between GTN and the Defenseless Automatic Addressing System (DAAS)/Logistics Information Processing System (LIPS).

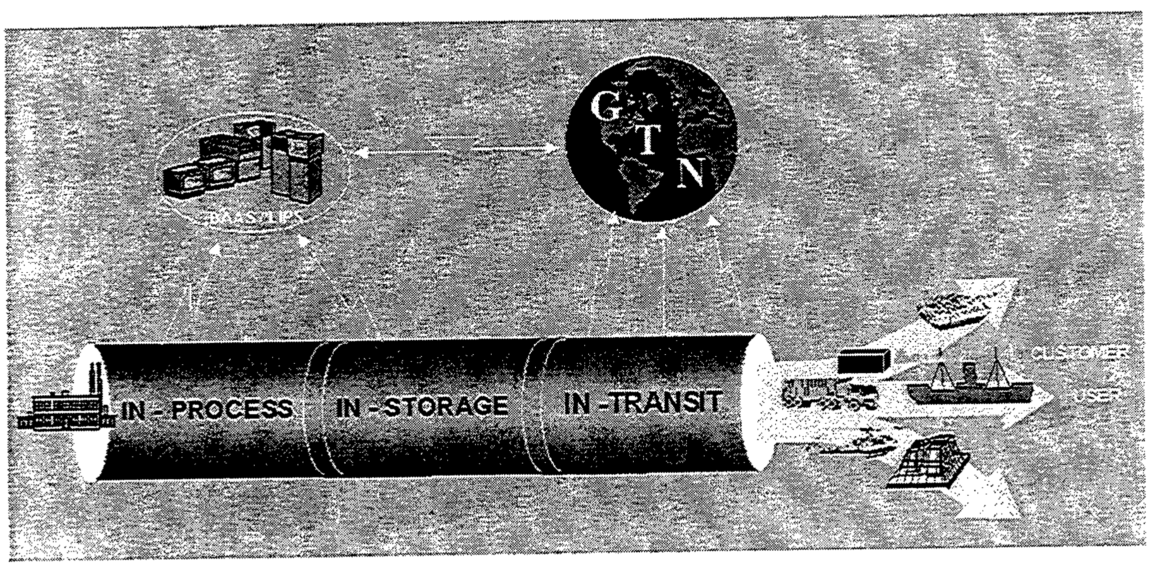


Figure 20. **Total Asset Visibility** (Monday, 1999a)

In a perfect world, "information should be collected and captured in the company's online information system only once – at the source where it was created. This approach

avoids erroneous data entries and costly reentries" (Chase, 1998:771). Ideally, GTN would be able to access information on any product that is intransit by looking in the DAAS/LIPS. "DoD has not yet developed an architecture for a long-term TAV program that incorporates inprocess, intransit and instorage visibility requirements into a shared data environment (SHADE)" (USTRANSCOM, 1997). Once SHADE is developed, many of the high data capacity AIT devices would no longer be necessary. As long as a link to the master database could be achieved, scanning a simple bar code would give the computer system access to all the product information previously captured during production. Until total asset visibility becomes a reality, automatic identification technology can be viewed as a temporary measure to ensure intransit visibility.

Appendix A: Aerial Port ITV Unit Type Code (HQ AMC Message)

RAAUZYUW RHCUAAA9255 1821609-UUUU--RUEOLIA.
ZNR UUUUU
R 011342Z JUL 98
FM HQ AMC SCOTT AFB IL//DOZ//
TO RUHUTRM/15AF TRAVIS AFB CA//DOZ//
RUEOLIA/21AF MCGUIRE AFB NJ//DOZ//
INFO RUHVAAA/615AMSG HICKAM AFB HI//CC//
RHFQALG/621AMSG RAMSTEIN AB GE//CC//
RHFQAAA/623AMSS RAMSTEIN AB GE//CC//
RUFAPVN/625AMSS ROTA SP//CC//
RHFTAMS/626AMSS RHEIN MAIN AB GE//CC//
RUDOVFV/627AMSS RAF MILDENHALL UK//CC//
RUQNAMS/628AMSS INCIRLIK AB TU//CC//
RUVACEA/629AMSS LAJES FIELD PO//CC//
RUAHAMS/630AMSS YOKOTA AB JA//CC//
RUADPDA/631AMSS OSAN AB KO//CC//
RUWMHGS/632AMSS ELMENDORF AFB AK//CC//
RHAKAAA/633AMSS KADENA AB JA//CC//
RHHEAAA/634AMSS ANDERSEN AFB GU//CC//
RUHVAAA/635AMSS HICKAM AFB HI//CC//
RUEOLIA/305APS MCGUIRE AFB NJ//CC//
RUEBEJA/436APS DOVER AFB DE//CC//
PAGE 02 RHCUAAA9255 UNCLAS
RUEOSLA/437APS CHARLESTON AFB SC//CC//
RUHUTRA/60APS TRAVIS AFB CA//CC//
RUWMFLA/62APS MCCHORD AFB WA//CC//
RUHUTRA/615AMOG TRAVIS AFB CA//CC//
RUHUTRA/615AMS TRAVIS AFB CA//CC//
RUHUTRA/715AMS TRAVIS AFB CA//CC//
RUHUTRA/815AMS TRAVIS AFB CA//CC//
RUEOLIA/621AMOG MCGUIRE AFB NJ//CC//
RUEOLIA/621AMS MCGUIRE AFB NJ//CC//
RUEOLIA/721AMS MCGUIRE AFB NJ//CC//
RUEOLIA/821AMS MCGUIRE AFB NJ//CC//
RHCUAAA/HQ AMC TACC SCOTT AFB IL//XOG//
RHCUAAA/HQ AMC SCOTT AFB IL//DON/IGI/DOO//
RUVRAFA/HQ AFRC ROBINS AFB GA//DON//
RHDJANG/ANGRC ANDREWS AFB MD//LGT//
RUEAHQA/HQ USAF WASHINGTON DC//ILTR//
RUEOLIA/AMWC MCGUIRE AFB NJ//WCOT//
BT
UNCLAS
SUBJ: AERIAL PORT INTRANSIT VISIBILITY (ITV) UNIT TYPE CODES (UTCS).
PAGE 03 RHCUAAA9255 UNCLAS
REF: HQ AMC/DOZ 171400Z JUN 98, SAME SUBJECT.
1. THIS MESSAGE PROVIDES DETAILS CONCERNING REFERENCED MSG.

2. THREE NEW ITV UTCS SUBMITTED TO HQ USAF FOR APPROVAL WERE
DEVELOPED BASED ON THE EXPERIENCE OF A LARGE GROUP OF BRIGHT NCOS WHO

WORK RCAPS 3.3 (SUPER RCAPS) IN THE FIELD. THE FOLLOWING ARE THE DETAILS OF THE NEW UTCS.

3. NEWLY DEVELOPED UTC MISCAPS:

A. UFBVP: APO ITV MOG-SHIFT 2/1. PERSONNEL ONLY. PROVIDES PERSONNEL TO OPERATE RCAPS/GTN (ITV) EQUIPMENT AND PERFORM MANIFESTING AT CARGO AND/OR PASSENGER ON/OFFLOAD LOCATIONS. THIS UTC IS CAPABLE OF SUPPORTING A 12 HOUR OPERATION MOG OF 2 UNIT MOVE OPERATION. USE WITH UFBVE. MAY REQUIRE AUGMENTATION WITH A COMMUNICATION SUPPORT UTC.
B. UFBVE: APO ITV EQUIP MOG 2. EQUIPMENT ONLY. PROVIDES INITIAL RCAPS/GTN (ITV) WITH EQUIPMENT PERMITTING REMOTE FILE TRANSFERS. THIS UTC CAN SUPPORT OPERATIONS UP TO A MOG OF 2 FOR 24 HOURS. REQUIRES DEDICATED ACCESS TO NIPRNET COMMERCIAL PHONE, DSN, OR
PAGE 04 RHCUAAA9255 UNCLAS
INMARSAT FOR COMMUNICATIONS CONNECTIVITY; COMMUNICATION MODE MUST HAVE A MINIMUM DATA RATE OF 9600 BITS PER SECOND (BPS). USE WITH UFBVP. MAY REQUIRE UFBVA FOR AUSTERE AREA OPERATIONS AND/OR BUILDING UTC FOR MOG OF 4 OR GREATER. MAY REQUIRE COMMUNICATION SUPPORT UTC WITH DEDICATED TRANSMISSION SYSTEM.
C. UFBVA: APO ITV EQUIP AUGMNT. EQUIPMENT ONLY. PROVIDES AUGMENTATION AND SPARES EQUIPMENT TO BE USED WITH UFBVE. EQUIPMENT CONSIST OF ONE PC WORKSTATION TO OPERATE AS A SERVER SUPPORTING TWO UFBVES WHEN HANDLING MOGS OF 4 OR GREATER. CONTAINS SPARES FOR DEPLOYMENTS INTO AUSTERE AREAS WHERE LOCAL SUPPORT IS NOT FEASIBLE.
4. MANPOWER DETAIL (UFBVP). TWO AIR TRANS JRNYMN (AFSC 2T251) AND ONE AIR TRANS CRFTMN (AFSC 2T271).
5. EQUIPMENT DETAIL UFBVE.
A. THREE EACH COMPUTER, LAPTOP, DURABLE.
B. COMPUTER HARDWARE--EXTERNAL/INTERNAL FLOPPY AND CD ROM DRIVES, SERIAL CABLE, POWER CORD, POWER UNIT, ETHERNET/MODEM CARDS W/ APPROPRIATE 10 BASE T (RJ45) OR 10 BASE 2 COAXIAL, AND JAZZ (2G MIN.) DRIVE. JAZZ DRIVE SHOULD BE CONNECTED BY PMCIA CARD (SCSI) AND APPROPRIATE CABLE. IF CONNECTED BY PARALLEL PORT, A PRINTER CANNOT BE USED AT THE SAME TIME.
PAGE 05 RHCUAAA9255 UNCLAS
C. SOFTWARE/MANUALS--RCAPS 3.3 (SUPER RCAPS), WINDOWS 95, NETSCAPE, DRIVER SOFTWARE (SOUND, MODEM, PRINTER, ETC), MS OFFICE PRO, ANTI VIRUS, CALM, JET FORM, ELECTRONIC FORMS ON CD, ACROBAT READER, 10 BOXES OF BLANK DISKETTES, 5 BLANK JAZZ DISKS.
D. REGULATIONS--AFJAM 24-204, AMCI 24-101 (ALL VOLS), DTR PI, II, & III.
E. ONE EACH CELL PHONE--GLOBAL CELLULAR PHONE W/DATA CAPABILITIES.
F. TWO EACH PRINTERS--RECOMMEND CANON BJC 80 W/EXTRA PRINTER RIBBONS/CARTRIDGE, CABLES.
G. TWO EACH 8 PORT HUBS--WITH 10 BASE T & BNC CONNECTIONS AND 3 T CABLES.
H. THREE EACH POWER KITS--SURGE PROTECTORS, POWER CONVERSION EQUIPMENT (TRANSFORMER, GLOBAL OUTLET CONVERTER KITS), TELEPHONE CONVERSION EQUIPMENT, 100 FT TELEPHONE CORD (RJ11), 25 FT EXTENSION CORD, 25 FT OF LAN CABLES.
I. ONE EACH COPIER, PORTABLE--WITH REPLACEMENT TONER CARTRIDGES.
6. EQUIPMENT DETAIL UFBVA.
A. ONE EACH COMPUTER, LAPTOP, DURABLE.

B. COMPUTER HARDWARE--EXTERNAL/INTERNAL FLOPPY AND CD ROM DRIVES,
PAGE 06 RHCUAAA9255 UNCLAS
SERIAL CABLE, POWER CORD, POWER UNIT, ETHERNET/MODEM CARDS W/ APPROPRIATE 10 BASE T (RJ45) OR 10 BASE 2 COAXIAL, AND JAZZ (2G MIN.) DRIVE. JAZZ DRIVE SHOULD BE CONNECTED BY PMCIA CARD (SCSI) AND APPROPRIATE CABLE. IF CONNECTED BY PARALLEL PORT, A PRINTER CANNOT BE USED AT THE SAME TIME.

C. SOFTWARE/MANUALS--RCAPS 3.3 (SUPER RCAPS), WINDOWS 95, NETSCAPE, DRIVER SOFTWARE (SOUND, MODEM, PRINTER, ETC), MS OFFICE PRO, ANTI VIRUS, CALM, JET FORM, ELECTRONIC FORMS ON CD, ACROBAT READER, 10 BOXES OF BLANK DISKETTES, 5 BLANK JAZZ DISKS.

D. REGULATIONS--AFJAM 24-204, AMCI 24-101 (ALL VOLS), DTR PI, II, & III.

E. ONE EACH PRINTER--RECOMMEND CANON BJC 80 W/EXTRA PRINTER RIBBONS/CARTRIDGE, CABLES.

F. ONE EACH 8 PORT HUBS--WITH 10 BASE T & BNC CONNECTIONS AND 3 T CABLES.

G. ONE EACH POWER KIT--SURGE PROTECTORS, POWER CONVERSION EQUIPMENT (TRANSFORMER, GLOBAL OUTLET CONVERTER KITS), TELEPHONE CONVERSION EQUIPMENT, 100 FT TELEPHONE CORD (RJ11), 25 FT EXTENSION CORD, 25 FT OF LAN CABLES.

H. ONE EACH COPIER, PORTABLE--WITH REPLACEMENT TONER CARTRIDGES.
PAGE 07 RHCUAAA9255 UNCLAS

I. TOOLS--COAX CABLE TOOL KIT, CRIMPING TOOLS/PARTS (CONNECTORS, T'S TERMINATORS, BOX 10 BASE T CABLE, 10 BASE T (RJ45/RJ11) CONNECTORS).

7. THE 437 APS IS THE PILOT UNIT FOR THESE UTCS AND THEIR WORK MAY LEAD TO CHANGES IN THE EQUIP UTCS. ONCE HQ USAF APPROVES THE UTCS, WE PLAN TO ASK 437 APS TO CONTINUE THE DEVELOPMENTAL WORK AND ACTUALLY ASSEMBLE KITS TO HELP US GET A HANDLE ON THE COST OF THE COMPONENTS.

8. WE HAVE NOT YET DETERMINED FUNDING SOURCES FOR THESE ITEMS.

9. THIS IS A HQ AMC/DOZ/DON COORDINATED MESSAGE. HQ AMC/DOZ POC IS MAJ JAY SCHAEUFELE, DOZX, DSN 576-3684. HQ AMC/DON POC IS LT COL JOE DILIBERTO, DONI, DSN 576-4718.//
BT
#9255

Appendix B: UFBVE Equipment List (621 AMOG)

UFBVE-1 Kit 1 - Package

2/12/99

UFBVE: APO ITV MOG 2/24hr	Required	Onhand	Details
1. 3 Laptop Computers (Panasonic)	3		
(1) Serial# 7JKSB04343 CF-25			
(2) Serial# 7JKSB04354 CF-25			
(3) Serial# 8AKSA02644 CF-35 (team chief)			
2. Included with Laptop package			
Removable CD-Rom and Floppy Drive	3 ea.		
(1) Serail# 7HKSE13082			
(2) Serial# 7HKSE13138			
(3) Serial# 8GKSC18935 (team chief)			
External Mouse/Mouse Pads *(1 team chief)*	3		
AC Adapter for Laptops *(1 team chief)*	3		
3com Ethernet Combo Cards (LAN+33.6)	3		
(1) Serial# 6HX1EEBC0C			
(2) Serial# 6HX1F06974			
(3) Serial# 6HX1FE95F7 (team chief)			
Modem Cable & PC LAN Adapter w/ lan coupler	3 ea.		
RJ45/10 baseT Cable *(1 team chief)*	3 ea.		
Phone cord/Coupler *(1 team chief)*	3/3		short 2 couplers
3. Printers with accessories (Canon BJC-80)	1		
Serial# XBW87073			
AC Adapter for Printers *(1 team chief)*	1		
Printer Cable	1		
Printer Cartridges	3		
BCI-10			
4. 8-port hub	1		
Serial# 7TKB070C2F			
AC Adapter	1		
25-ft. LAN Cable	3		short 2 cables
5. JAZ "2 Gig" External Drive (Iomega)	1		
Serial# X12V120MVJ			
AC Adapter	1		
SCSI Cable	1		
Parallel Cable & JAZ Traveller Adapter	1 ea.		
Back up JAZ disc	2		
JAZ install disc	1		
6. Additional Miscellaneous Equipment			
Surge Protector/110/220	2		
Power/Telephone Conversion Kit	1 ea.		short phone kit
Printer Paper Ream	1		
Box of Double-Sided/ Double Density Blank Discs	5-10		
25ft. Phone cord w/ 2to1	1		short 2to1
25ft. Extension Cord	1		
Bag of Quick Ties	1		
ITV System Administrators Guide	1		
Small Transformer/foam cushioning	35796		

I acknowledge receipt of and responsibility IAW AFR 20-14 for the items listed above and will return them by the return date indicated.

ISSUE TO: SIGNATURE	DUTY PHONE	ISSUED BY
ISSUED TO: NAME, GRADE, SECTION	DATE OF ISSUE	RETURN DATE

(Norwood, 1999)

Appendix C: UFBVA Equipment List (621 AMOG)

UFBVA-1 Package

2/12/99

UFBVA: APO ITV MOG 2/24hr	Required	Onhand	Details
1. Laptop Computers (Panasonic)	1		
Serial# 8AKSA02641			
2. Included with Laptop package			
Removable CD-Rom and Floppy Drive	1 ea.		
Serial# 8GKSC19708			
AC Adapter for Laptops	1		
3com Ethernet Combo Cards w/ cables	1		
Serial# 6HX1FE95FC			
RJ45 & 10 base T cable	1 ea.		
Phone cord with coupler	1		
External Mouse w/ pad	1		short
3. Printers with accessories (HP 4L)	1		
Serial# USCC729970			
Spare Printer Cartidge	1		
Power Cord/Serial Cable	1 ea.		
4. 8-port Network Hub	1		
Serial# 505172861B			
AC Adapter	1		
25-ft. LAN Cable	3		short (need to make)
5. Copier (Canon)	1		
Serial# NTU44023			
Power Cord	1		
Spare Toner Cartridge	1		short
6. Additional Miscellaneous Equipment			
Surge Protector	1		
Power/Telephone Conversion Kit	1 ea.		short phone kit
Transformer	1		short
Printer Paper Ream	2		
Box of Double-Sided/ Double Density Blank Discs	5-10		
25ft. Phone cord	1		
25ft. Extension Cord	1		
Crimping Tool Kit	1		
Small Computers Tool Kit	1		

I acknowledge receipt of and responsibility IAW AFR 20-14 for the items listed above and will return them by the return date indicated.

ISSUE TO: SIGNATURE	DUTY PHONE	ISSUED BY
ISSUED TO: NAME, GRADE, SECTION	DATE OF ISSUE	RETURN DATE

(Norwood, 1999)

Appendix D: AMC Deployed ITV Course Syllabus

AMC Deployed ITV Course
Class: ***99007 17 – 21 May 1999***

Date	Lesson	Instructor
Monday	Class Registration	SSgt Ware
17 May	CC's Introduction	SMSgt Newton
	AMWC/Trans Branch Intro	SSgt Ware
	ITV Briefing	SSgt Ware
	Pre-test	SSgt Ware
	Intro to ITV hardware, software, and equipment issue	SSgt Ware
	System Set-up and Configuration (initial)	SSgt Ware
Tuesday	Intel Briefing	
18 May	System Set-up and Configuration (initial continued)	SSgt Ware
	Computer wipe	SSgt Ware
	System Set-up and Configuration (student practice)	All
	Computer wipe	All
	System Set-up and Configuration (student practice)	All
Wednesday	Intel Briefing	
19 May	Networking and Hub Connection	SSgt Young
	Mobility Site Location Change	SSgt Young
	RCAPS Practice Scenarios	SSgt Young/All
	Evaluation Practice Scenarios	SSgt Ware/All
Thursday	Intel Briefing	
20 May	GTN Tutorial (Student Paced)	All
	GTN Demo	SSgt Young
	INMARSAT Hook-up	SSgt Young/All
	Database Management	SSgt Kavanagh
	Computer wipe	All
	AMC VTC	SSgt Kavanagh
Friday	Intel Briefing	
21 May	Post-test	SSgt Ware
	End of Course Evaluation	All
	Computer wipe	All
	Graduation	

(AMWC/WCOT, 1999:v)

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Vita

Major Chris B. Patterson was born on 5 January 1965, in New Rochelle, New York. He graduated from Aloha High School in 1983, and entered undergraduate studies at the University of Portland, OR. He graduated maxima cum laude with a Bachelors of Science degree in Electrical Engineering in 1987.

He was an ROTC distinguished graduate and received his regular commission on 2 May 1987. After completing Undergraduate Pilot Training at Williams AFB, AZ, his first assignment was flying the C-141B Starlifter at Norton AFB, CA. While at Norton AFB, he flew many missions in support of Operation Just Cause, Desert Shield, Desert Storm, and Desert Calm. After upgrading to Instructor Pilot, he moved north to McChord AFB, WA. He spent four months in a career broadening position as section commander in a maintenance squadron. His next job was airlift director where he was responsible for producing and coordinating the wing's daily flying schedule. After three and a half years, he was selected to teach math at the United States Air Force Academy Preparatory School in Colorado Springs. In addition to teaching, he mentored students on military and leadership skills. His duties also included flying the TG-7A motor glider.

In June of 1998, he was chosen to enter the School of Logistics and Acquisition Management, Air Force Institute of Technology as part of the Advanced Study of Air Mobility (ASAM) program. He received a follow-on assignment to attend Air Command and Staff College at Maxwell AFB, AL.

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13. ABSTRACT *(Maximum 200 words)*
Air Mobility Command (AMC) is responsible for collecting intransit visibility (ITV) data at remote and austere airfields. Automatic identification technology (AIT) is emerging as a system for quick and accurate data capture. This paper examines the application of AIT at remote locations to obtain ITV. Four areas are addressed: processes, training, manning, and equipment.

Obtaining ITV at remote locations is currently a complicated combination of manpower and time intensive processes. AIT is capable of streamlining these processes by reducing cargo and passenger processing times. Additionally, it provides highly accurate data. Although AIT offers several significant benefits, the technical nature of AIT equipment requires skilled personnel for setup, operation, and troubleshooting. Recent AIT exercise scenarios highlighted the need for training programs at all levels from aerial port personnel to commanders. Furthermore, it does not appear that the application of AIT will reduce manning requirements. Despite these disadvantages, AIT could improve ITV at remote locations. Given that past attempts to collect ITV data at remote or austere locations have been manpower and time intensive, AIT could eliminate these problems in the future. Consequently, AMC should plan to use AIT to improve ITV at remote locations.

14. SUBJECT TERMS
Automatic Identification Technology (AIT), Intransit Visbility (ITV), Fly-Away Kit, Remote Location, Austere Location

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